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By Col. R. H. Elliot, I.M.S.

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To Illustrate "A Study of some Results of Infection of the Vitreous Body with Septic Material in Couched Eyes."

By Lieut.-Colonel Robert Henry Elliot, I.M.S. (Ret.)

Fig. 4.—A couched eye, showing tear in the iris and scars of the ciliary body and of the choroid.

Fig. 5.—A couched eye, showing extensive detachments of the retina and choroid.

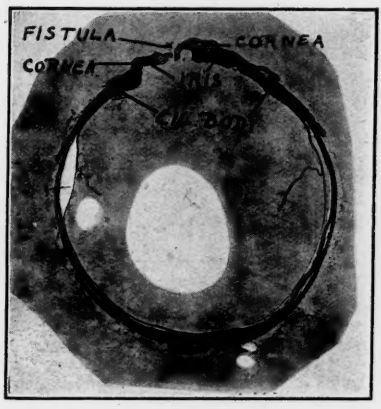

Fig. 6.—A couched eye, showing a permanent corneal fistula.

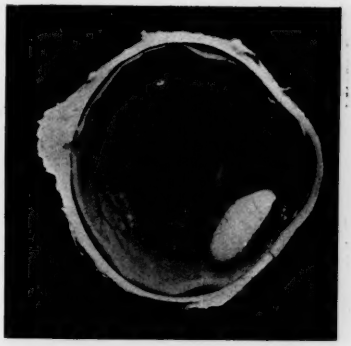

Fig. 7.—A couched eye. Notice the scleral fistula opposite the lens, and deeply cupped disc.

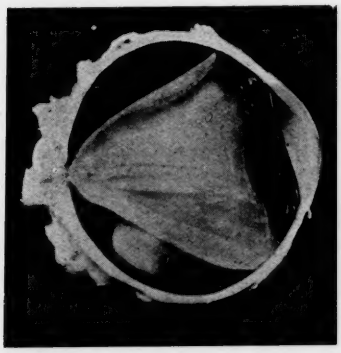

Fig. 8.—A Morgagnian cataract couched behind the retina.

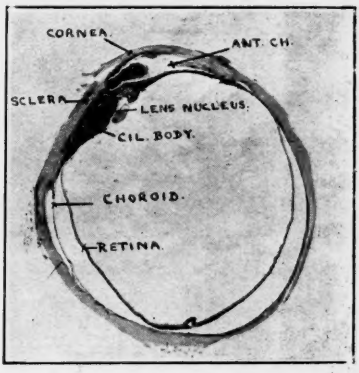

Fig. 9.—A cataract dislocated between the ciliary body and the sclera.

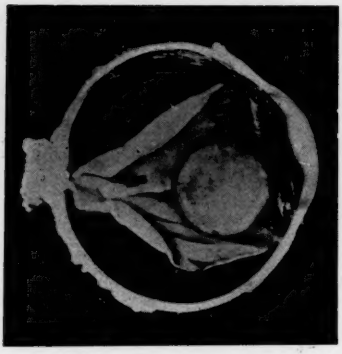

FIG. 10.—A large Morgagnian cataract couched into the vitreous chamber; the retina is extensively detached.

FIG. 11.—An abundant exudate into the vitreous chamber concealing a couched cataract.

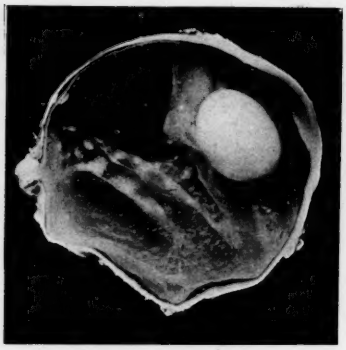

FIG. 12.—A large Morgagnian cataract lies embedded in an inflammatory exudate in the vitreous cavity; in this exudate are many white inflammatory foci.

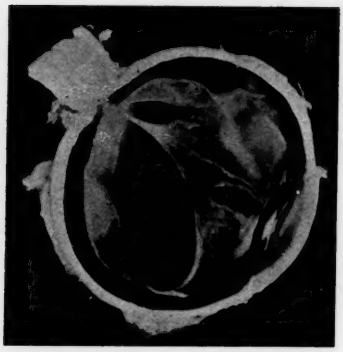

FIG. 13.—A couched eye in which the vitreous body is represented by a conical mass which has undergone a high degree of organization, especially toward its apex at the optic nerve, and again in the neighbourhood of the ora serrata.

FIG. 14.—An inflamed optic nerve head, showing a mass of exudate, occupying the physiological cup and bulging into the vitreous cavity; this mass is organizing, and new-formed vessels can be seen in it; it was the apex of a conical mass which represented the shrunken and infiltrated vitreous body.

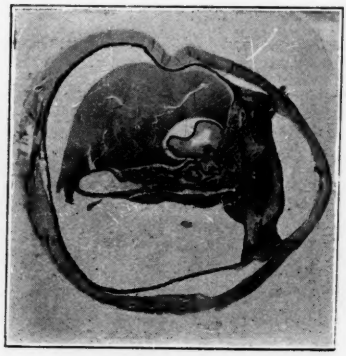

FIG. 15.—A section of a couched eye, showing the retina totally detached and rolled up into cysts. The lens is embedded in inflammatory exudate; there is great matting of the parts; the eye is shrinking.

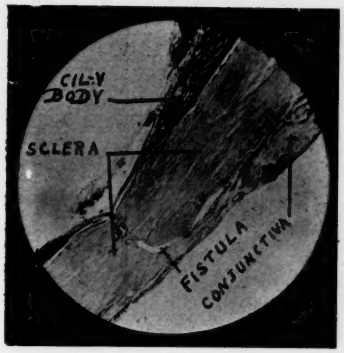

FIG. 18.—A low-power magnification of the scleral fistula shown in fig. 7.

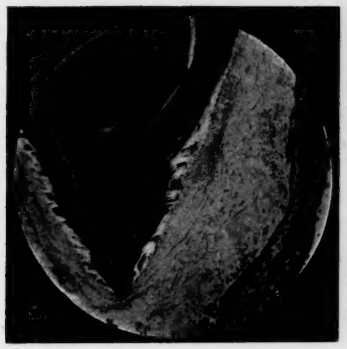

FIG. 19.—A higher magnification of fig. 14, showing the lens embedded in exudate and being attacked by phagocytes along its edges.

FIG. 20.—A high-power magnification of a portion of the previous specimen showing the large multi-nuclear phagocytes absorbing the lens fibres.

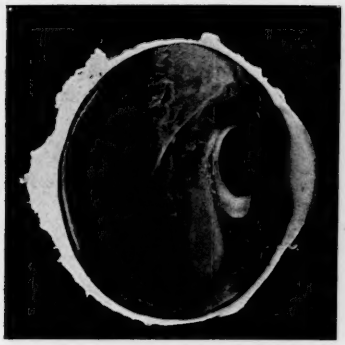

FIG. 21.—A hard nuclear cataract depressed and lying in front of the unruptured anterior hyaloid membrane, and therefore outside the vitreous cavity.

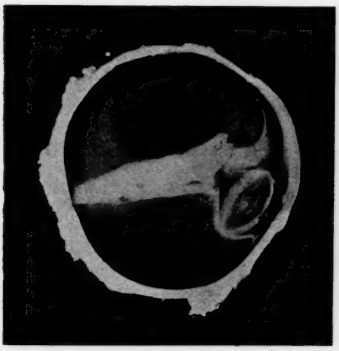

FIG. 22.—A couched cataract, showing stick-like detachment of the retina with great matting of the parts.

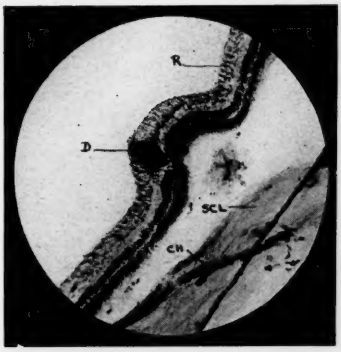

FIG. 23.—From a couched eye, showing a proliferative dot on the retina. R, retina; SCL, sclera; CH, choroid; D, mass of leucocytes surrounding a vessel.

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COMMUNICATIONS

A STUDY OF SOME RESULTS OF INFECTION OF THE VITREOUS BODY WITH SEPTIC MATERIAL IN COUCHED EYES*

BY
LIEUT.-COLONEL ROBERT HENRY ELLIOT, I.M.S. (Ret.)
LONDON.

IN 1911 Professor M. Straub, of Amsterdam, read a communication before the Ophthalmological Society on the pathology of certain opacities which develop in the vitreous as the result of the deliberate infection of the ciliary body with tubercle bacilli.† The experiments, carried out on rabbits, were two in number, and had for their object the further study of processes, which he had observed to occur in the vitreous when that body had been made the seat of the original focus of inflammation. His principal findings were as follows:—(1) The optic nerve head was inflamed and swollen, and its cup was filled up by leucocytes. (2) In the vitreous body were found a number of leucocytes, seated on thin membranes, and lying on the plane between the granuloma, which had developed as a result of the infection, and the inflamed optic nerve head. (3) Aggregations of leucocytes were found on the walls of the cavities of the eye (on the cornea, on the retina, on the lens capsule, and in cavities of the vitreous). From these observations he concluded "that the lymph

*A communication to the Section of Ophthalmology of the Royal Society of Medicine.
†*Trans. Ophthal. Soc. U.K.*, Vol. XXXII, 1912, p. 60.

current of the vitreous goes by the optic nerve, and that chemotactical substances are brought by this current from the granuloma to the nerve." He also drew the inference "that in cyclitis" (presumably of traumatic origin) " a slight haziness of the optic nerve and the adjacent retina and a slight swelling of the disc must be expected." He attributed all the changes alike to chemotactic phenomena occurring as the result of the influence of toxins, which entered the vitreous and aqueous chambers by diffusion, or were carried into them by the lymph stream.

In the course of his address Professor Straub dealt with other matters, the majority of which do not interest us in this communication.

When the writer first began to study the eyes, which had been removed in the Madras Hospital, as the result of failure following couching for cataract performed by native surgeons, one of the first features to attract notice was the prevalence in these eyes of changes in the vitreous. This was not unexpected, for, in a large number of the cases examined clinically, it had been observed that ophthalmoscopy was rendered difficult or impossible as a result of opacification of the vitreous body. The results of endeavouring to remove couched lenses in India were so unsatisfactory that it became a rule of the Hospital to leave them alone save in very exceptional cases, the reason for this being that European surgery was apt to be discredited by the bad results obtained, which, under the influence of the coucher, were too often ascribed to the operation performed for the relief of the condition brought about by his clumsy and septic procedure. Colonel Kirkpatrick, the present Superintendent of the Madras Hospital, has removed a number of these couched lenses, and has been " struck by the rarity of vitreous escape, even after a fairly extensive investigation with a spoon, in extracting couched lenses." He adds: " I have noticed that the vitreous body becomes shrunken and extraordinarily tough, so much so that when an eye is excised (either for glaucoma or for iridocyclitis following Mahomedan interference), the whole globe can be held up by a strabismus hook transfixing the vitreous, though the latter appears perfectly clear. The vitreous undoubtedly does undergo shrinkage, and leaves a large space, which is occupied by aqueous " (Personal communication).

As time went on, we were enabled to collect a large mass of clinical and pathological material, the former consisted of the carefully taken notes of 780 consecutive cases in which couching had been performed, the latter of 54 globes, removed either for the relief of pain, or because they were deemed a possible danger to the other eye. In order to understand the changes in the vitreous body which we found in these globes, it is necessary to preface the discussion by a short statement of certain facts: 1. The methods of the

coucher are wholly innocent of any effort towards the attainment of asepsis or antisepsis. His hands are filthy, his tools worse, and his operations are conducted in the dirt and dust of an Indian village street, or on the mud-plastered pial, or foundation, of a native house (*Fig. 1*). 2. The virulence of the infective matter he conveys into

FIG. 1.—The operation of couching.

the interior of an eye varies enormously in different cases. Surprising as it may seem, the eye sometimes escapes infection. On the other hand, there is no doubt that a large number of couchings result in panophthalmitis. Between these two extremes, there stretches out a long line of infections, varying in type from the mild to the extremely acute. 3. The operation performed is not in all cases the same, for there are two distinct types of procedure practised by the Indian coucher, for which I have ventured to suggest the names of "the anterior" and "the posterior" operations respectively. In the former, the instrument enters through the cornea and attacks the lens through the iris or pupil (Fig. 2); in the latter, the route adopted is through the sclera behind the ciliary body, and the attack is upon the posterior capsule of the lens or its suspensory ligament (Fig. 3). In the former, the anterior portion of the uveal tract and the aqueous chamber are principally infected, whilst in the latter, the choroid, the retina, and the vitreous are made the primary depositories of the septic material introduced. (4) The amount of damage inflicted

accidentally on the different structures of the eye varies enormously, not only according to the technique adopted, but also with the skill of the surgeon and with the behaviour of the patient. To perform such an operation as couching without the aid of a speculum, and often without the employment of a local anaesthetic, would call for a high measure of dexterity even in a tractable and courageous patient, whilst with nervous, troublesome, ignorant, and undisciplined subjects, the operation must be difficult to the last degree. It is quite clear that the amount of trauma inflicted will have a considerable influence on the nature of any septic process set up by

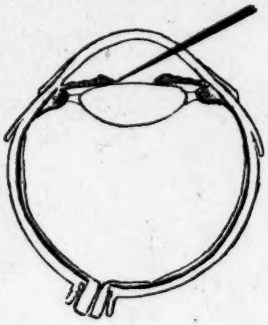

FIG. 2.—The anterior operation.

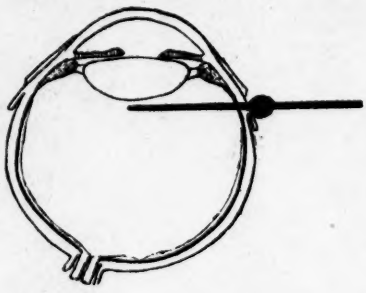

FIG. 3.—The posterior operation.

the introduction of dirty instruments within the eye. Now, no one can examine a large number of couched globes anatomically without being struck by the extraordinary difference in the amount of injury inflicted. In some the operation has been so beautifully done that one looks in vain for the track of the wound, whilst in others the havoc wrought is excessive; thus, one may find large tears in the iris and ciliary body (Fig. 4), extensive detachments of the retina and choroid (Fig. 5), permanent fistulae in the investing tunic of the eye (Figs. 6 and 7), the vitreous extensively broken up by the dislocation of the lens, lenses driven through the retina into the subretinal space (Fig. 8), or through the pectinate ligament by way of the anterior chamber into the subchoroidal space (Fig. 9), etc.

There is a last preliminary point of some importance, and it relates to a tendency to deal with this material, as if, since it is founded on the material derived from an operation, which is rarely, if ever, done in European countries, it is only of interest to those who work in Eastern lands. I would ask you to forget for the moment the method by which the globes have been obtained, and to consider them simply as a series of eyes infected by the introduction into their interior of septic material of varying grades of virulence, attended by varying grades of accidental traumatism, and

occurring in individuals of varying conditions of health and bodily resistance; in other words, to forget their Eastern origin, and to look on the subject in the broadest sense, as an opportunity of studying the results of a large number of experiments performed (unintentionally, it is true) by the Indian coucher on human material.

Having thus cleared the ground, we are in a position to study the subject of our paper, viz., the changes produced in the vitreous by the introduction of septic matter during the operation of couching. As has been indicated, the evidence of such changes varies enormously in different globes, but it can probably be found, if carefully sought for, in every case. In some, the presence of a few threads in the vitreous is all that is to be seen (Fig. 10), in others, a filmy mass is found in the chamber. This may be confined to its anterior portion, or may take the form of a cone, with its apex at the nerve head, and its base in the neighbourhood of the ora serrata and of the ciliary body. In other globes, comparatively firm masses are present, which are freely infiltrated with inflammatory material, either throughout their substance (Fig. 11), or in isolated foci (Fig. 12). In others, the contents of the vitreous are frankly purulent, the eye being in a condition of panophthalmitis. In yet others, the vitreous body is represented by a detached and shrunken conical mass, which may show a higher or lower grade of fibrous organization (Fig. 13). Lastly, there are eyes in which no evidence of the original vitreous can be made out, since the retina has become detached and inextricably matted with inflammatory material, which had first infiltrated, and later replaced, the vitreous contents, the iris and ciliary body being included in the felted mass (Fig. 14).

In seeking to ascertain the method of infection of the vitreous, a point that early attracted our attention was that in some cases the exudate found was confined to the anterior portion of the vitreous chamber, whilst in others, it extended backward, as has already been mentioned, in a cone, whose apex was tethered to the optic nerve. In no case was the posterior portion of the chamber alone affected. The suggestion that naturally occurred to the mind of anyone examining such specimens, was that possibly we were dealing with two distinct classes of case (1) those in which the anterior portion of the vitreous was alone affected by an exudate poured out from the ciliary body, and (2) those in which the whole of the vitreous was permeated, either by exudates from the whole of the uveal tract and from the retina as well, or by a direct infection of the vitreous body setting up such a chemotactic action as had been suggested by Straub. Further investigation proved that there was no real distinction between the two sets of cases, and that in all alike the whole of the vitreous body was involved. The first definite proof of this came from two specimens, which, when examined in India,

had shown a most definite cone of organized vitreous exudate, but which, when they arrived in England after a long sea journey, appeared to be typical instances of infection of the anterior portion of the vitreous alone. Once this clue had been obtained, the explanation was simple enough. The apex of the cone in the vitreous chamber is often extremely slender, and it is not difficult to understand that it might easily be broken through unless the specimen was very gently manipulated. This explains the specimens, which were altered during transit home, but the same line of reasoning will cover a number of others. If, in dividing the frozen globe, the surgeon is not extremely careful to cut just to one side of, and strictly parallel to the median plane, it is self evident that the slender apex of the cone may easily be divided, with the result that the mass of exudate will spring forward toward its large and firm attachment in the neighbourhood of the ora serrata; it is well known that the vitreous body is normally attached to an area round this belt. Again, there is abundant evidence that the cone of exudate in the vitreous has a strong tendency to contract under the pathological process following infection. Apart altogether from the fact that it is well known that organizing fibrous tissue tends to contract, our specimens show abundantly how strong this pull can be on adjacent structures. It may detach the retina and choroid from their beds; it may pull on the optic nerve, dragging it forward into the vitreous chamber; it may drag the retina forward over the ciliary body; and it may even shorten the antero-posterior diameter of the sclero-corneal envelope. It is, therefore, quite conceivable that the slender attachment of the apex of the cone to the optic nerve may be broken off even during life, as a result of this pull. If the fracture takes place very close to the nerve head, anatomical evidence that such a pedicle ever existed may only be obtainable under the microscope. The importance of getting a clear understanding of this matter lies in the fact that a further study of the specimens lends no support to the idea of a local infection of the vitreous body. Now if, following Straub's views, we were to argue that a dirty thorn or needle thrust into the vitreous would be likely to deposit septic matter there, just as we deposit bacterial organisms in a gelatinous culture medium in a test tube, we should probably be justified in expecting to find some measure of localization, or of septic action in the vitreous body. Such an expectation has been uniformly disappointed. The whole of the vitreous body appears, from the first, to be more or less evenly impregnated with inflammatory material, although, as might have been expected, the areas of most profuse exudation and of earliest organization are: (1) in the neighbourhood of the ciliary body and (2) in that of the optic nerve head (Fig. 13). The explanation of this peculiarity is obviously to be sought in the

closeness of these two areas to the sources of vascular supply, and not at all to the method of original impregnation of the vitreous.

Before leaving the subject, there is a farther point of interest to be considered. The greater advance in the organization of the cone of exudate in the neighbourhood of the ciliary body is only what might have been expected, and calls for no comment; but that in the neighbourhood of the optic nerve is less easy to understand; except on the assumption that there is some measure of lymph current passing backward from the vitreous to find an escape at the scleral foramen, either in or around the optic nerve. Microscopical preparations show definite blood-vessels in the apex of this cone of exudate (Fig. 14). These vessels are clearly tributaries of the central retinal vessels. Now, it is difficult to imagine that such a state of things could exist, except as a result of a backward flow of chemotactic substances toward the lymphatic channels in or around the optic nerve. It is not, perhaps, universally admitted that any such flow of lymph is usually present in the normal eye, the general tendency being to assume that this fluid escapes either: (1) through the anterior route (by the ligamentum pectinatum and iris crypts), or (2) by the equatorial route (around the venae vorticosae). Three possible channels of escape have been suggested for the lymph current at the posterior pole of the eye, viz.: (1) outside the dural sheath, (2) by the intervaginal space, between the sheaths of the optic nerve, and (3) along the central canal of the vitreous and the trunks of the central retinal vessels. Fuchs, speaking of this last channel ("Text Book of Ophthalmology," Fourth English Edition), states that while the matter is still under dispute, pathological processes argue the existence of such a lymph passage, which runs in the vitreous straight back to the head of the optic nerve, since even in slight inflammations of the anterior portion of the eye, the optic papilla may be found implicated, even though the rest of the back of the eye is still normal, so that we must assume that irritant substances from the focus of inflammation can get to the optic nerve by a direct channel through the vitreous. This, however, does not seem to be necessarily the only solution of the phenomena to which he refers. Leboucq ("Lymphatic Channels of Eye and Orbit," *Soc. belge d'Ophtal.*, No. 35, p. 46, and No. 36, p. 63) made a number of experiments on rabbits, which led him to believe that there is in the orbit a lymphatic system for the outflow of aqueous humour which is completely independent of the venous system. He found three channels of outflow in these animals: (1) an interior in the neighbourbood of the angle of the anterior chamber, (2) a median by the lymph sheaths of the vorticose veins, and (3) a posterior by the lymph sheaths of the optic nerve. The fact that the last-named channels are to be found normally

in rabbits would invite the presumption that they might possibly exist, though probably not to the same extent of development in man. Such a supposition appears to find support from the following facts: (1) In this long series of septically infected globes the presence of a cone of exudate in the vitreous is practically a constant feature; (2) the apex of that cone is always attached to the optic nerve head, or in its near neighbourhood; (3) in a certain number of cases there is definite evidence of congestion or inflammation of the optic nerve head; (4) the cone in question obviously represents *the whole* of the shrunken vitreous, and not merely the part surrounding such a central canal as Fuchs seems to visualize. The obvious explanation would appear to be that there is, even in man, some measure of lymph flow towards the posterior pole of the eye, and this carries with it for excretory purposes any septic products, which have been introduced into the interior of the eye by dirty instruments, or which are thrown into the vitreous body by the surrounding vascular structures, as a result of their inflammation. It might be argued that the vitreous body is, under normal conditions, attached to the optic nerve head, and that this fact would sufficiently explain the attachment in question. This is true; but other points have to be taken into consideration, viz., (1) that the anterior attachment of the vitreous in the neighbourhood of the ciliary body has vascular and lymphatic relations with the important structures in its vicinity there; (2) that the organization of the cone of vitreous, and such organization includes the formation, under favourable circumstances, of new formed blood-vessels (Fig. 14) proceeds most rapidly, and advances to the greatest extent, in the two neighbourhoods in question; (3) that a distinct inflammation of the optic nerve head was present in a certain number of the globes examined anatomatically; and (4) that optic neuritis and optic atrophy were seen in other eyes examined during life. If all these points be taken into consideration, they appear to afford a strong presumption of the presence of a backward flow of lymph from the vitreous body to the posterior pole of the eye. Several specimens show in the middle of the cone of exudate what would appear to be an evidence of the existence of a hyaloid canal. Unfortunately, this surmise cannot be confirmed without destroying valuable and irreplaceable specimens.

To return to the paper read before the Ophthalmological Society by Professor Straub. In that communication, the author contended strongly for the acceptance of the term "hyalitis," on the ground that the deposition of septic matter in the vitreous body had been responsible for a chemotactic action, which had caused the inflow of inflammatory products into that body, and therefore had established a state of inflammation within it. To this exception was taken by Mr. Parsons on the ground that the rôle of the vitreous

body was a purely passive one, and that the inflammatory action should be referred to the ciliary body in which it was really seated. It is true that in Straub's experiments there must have been an abundant and direct infection of the vitreous body with septic matter, but there was also present a very definite infection of the ciliary body itself, and the reaction set up in that body would seem to have been quite sufficient to account for all the vitreous changes observed. Our point is that it was not necessary to premise (1) an infection of the vitreous body, (2) the diffusion of the poison so introduced, and (3) the resulting chemotaxis to account for the phenomena observed, since the lesion in the ciliary body alone would have sufficed to explain all the changes present.

The same is true of all the globes which have been removed and examined after couching, It is possible, and even probable, that the introduction of a dirty instrument into the globe coincidentally with the wide opening up of the vitreous that occurred in many of the cases, caused an even more definite and widespread infection of the

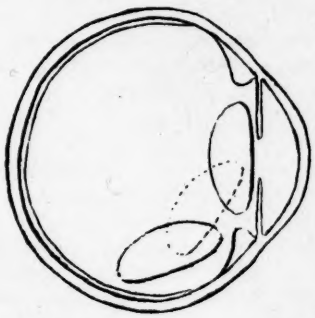

FIG. 16.—Diagram to show the path of a lens during depression.

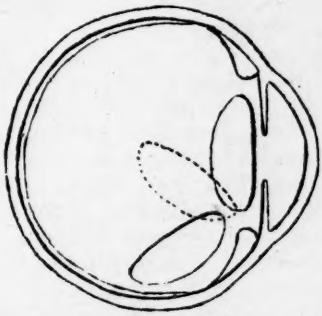

FIG. 17.—Diagram to show the path of a lens during reclination.

vitreous body than that met with in Straub's experiments (Figs. 16 and 17). Moreover, in very many cases, the instrument was actually introduced right into the vitreous itself, but one could not attribute the changes found to this infection of the vitreous alone, since one must obviously take account of the other structures of the eye which were injured at the same time, and not least of the ciliary body. Before going any further, we must therefore discuss shortly the lesions of these other structures, and the results which accrued from them.

The sclero-corneal tunic.—The coucher's instrument is introduced either through the cornea, the limbus or the sclera, and several of our specimens show the results of the inflammatory action induced in these structures thereby. Long afterwards, the track of the

instrument remains marked out by the reaction of the sepsis produced, or a permanent fistula of the cornea or the sclera may be left (Figs. 6 and 18).

The uveal tract.—In quite a large number of couched eyes one finds extensive scars in the iris, in the ciliary body and in the choroid, or in two or more of these structures (Fig. 4). In association with these injuries, we find a uveitis very widely prevalent. The intensity of this inflammation and its seat vary considerably. In some the evidence of iritis, of iridocyclitis, of cyclitis, or of choroiditis requires careful looking for, whilst in others, the inflammatory process had been so severe as to result in a fulminating panophthalmitis. A very important point is the type of inflammation present which, with one solitary exception, was always plastic in nature, and was mostly confined to the iris and ciliary body. The plastic mass poured out from these structures had in many cases enveloped the remains of the lenses (Fig. 14), which can be seen in process of disintegration under the action of phagocytosis or of fluid absorption (Figs. 19 and 20). Allusion has been made to one instance of proliferative uveitis, and in this one the nodule in the iris consists of mononuclear lymphocytes; epithelioid and giant cells are conspicuous by their absence. In the series of globes before us, we can trace every stage of the changes produced in the vitreous body as the result of the inflammatory action in the surrounding parts. Much depends on the stage at which we see the eye and on the intensity of the inflammatory process, which has been excited in it. In early and mild cases, the vitreous is found to be hazy, the membranes described by Straub are present, cellular elements are scanty and difficult to demonstrate, the anterior hyaloid membrane (the term is used without prejudice) may be definitely thickened and infiltrated with inflammatory material. In better marked instances, the exudate reaches such a pitch of organization as to cause it to assume (under preparation for anatomical examination) the familiar shape of the vitreous cone. This, in turn, becomes better and better marked as organization proceeds; the area of greatest advance of these changes is, as has already been stated, in the neighbourhood of the ciliary body anteriorly and of the optic nerve posteriorly.

It is significant that so large a collection of infected globes presents very little evidence of inflammation of the choroid in spite of the fact that several of the eyes were wounded posteriorly to the ora serrata. The leading choroidal feature was the presence of atrophy, though doubtless this was largely secondary. In one very interesting case a caseating mass was found in the eyeball between the retina and the choroid; in this was found a fragment of metal, which was most unfortunately lost. The strong but strictly localized inflammation around this mass suggests that it was of

copper, an idea which derives support from the fact that these men use probes of that metal, wherewith to depress the lens, after making their preliminary incision. The extensive detachment of the retina in this case, and the other features of it, suggest strongly that the vitreous exudate, which, as we shall presently show, is responsible for the detachment of the retina, owed its origin to the uveitis present.

In the above argument there has been an underlying assumption that in all the globes under discussion the vitreous had been directly infected and widely laid open. Though true for the majority of the eyes, this is not so for all, and this brings us to a subject of more than ordinary interest. In a few of the cases we find the lens lying dislocated between the anterior hyaloid membrane (the term is used without prejudice and for convenience sake) and the iris, ciliary body, and ora serrata. Such are obviously cases of depression and not of reclination. There was therefore no opening up of the vitreous by the lens. Again, in one of these cases there is a strong presumption, and in another the certainty that the couching was performed from the front of the eye (as shown by an anterior synechia at the point where the instrument entered), and yet in both of these an organized vitreous exudate had formed (Fig. 21). It is therefore clear that we can find in the vitreous the exudate which characterizes the couched eye apart altogether from the opening up of that body, either by the dislocated lens or by the instrument used; its source must, in such cases, obviously be from the primary inflammation set up in the surrounding vascular structures by sepsis.

The retina.—Detachment of the retina occurred in 70 per cent. of the 54 globes examined. A few of the cases were slight in extent; the great majority were complete. If we put aside for the moment the consideration of those cases in which the detachment was either directly traumatic, or due to the haemorrhage following traumatism, we find that the rest, which constitute the great bulk of the cases, owe their detachment to the contraction of the inflammatory exudate which had been poured into the vitreous chamber, and which had formed adhesions to the retina. Every step of the process can be traced in the macroscopic and microscopic specimens. The earliest possible stage is seen under the microscope in sections of an eyeball, where the shrinkage of the exudate within the vitreous chamber had just commenced to lift the retina from its bed. The ultimate stage of the process is to be found in a number of globes, in which the retina is not only detached, but has shrunk posteriorly into a stick-like column, whilst it opens out anteriorly into a mass, in which the iris, the ciliary body, the lens, the remains of the vitreous and the retina are inextricably matted and tangled (Fig. 22). Every grade can be traced from the slightest detachments up to those we have just described. The degree of

separation of the retina is partly a question of time, but it is much more one of the character and grade of the inflammatory process excited in the eyeball, and of the time at which the examination is made. Obviously a great deal depends upon the nature and extent of the original infection. It will naturally be asked, what are the conditions which give rise to the formation of adhesions between the vitreous exudate and the retina. There are several: (1) The site of a retinal wound may form the point of connection between the exudate and the membrane (Fig. 5). (2) The deposition of septic matter within the vitreous chamber, and its wide diffusion throughout the hyaloid may set up a retinitis by chemotaxis. Evidences of such an inflammation of the retina abound in many of the specimens (Figs. 23 and 24). Such appearances

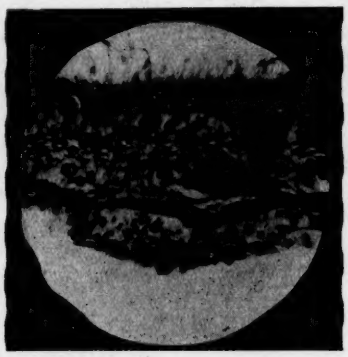

FIG. 24.—A collection of leucocytes, lying on the inner surface of the retina, superficial to its limiting membrane, and projecting freely into the vitreous. In the substance of the retina is the section of a vessel surrounded by a mass of leucocytes (from a couched eye).

would seem to be best explained on Straub's supposition referred to above. Everything that we know of the circulation of fluid within the vitreous would favour the idea that poisonous matter introduced into that body would speedily become diffused throughout its substance, and we may presume that its principal attack would be upon the wide surface of retina exposed to its influence. Now, a noteworthy point in our specimens is the presence of a number of greyish-white dots found scattered on its surface in a large percentage of the specimens. Conditions of time and space prohibit a full consideration of the nature of these dots which appear to differ widely in different globes, but in several of them they seem to find their explanation either in localized patches of proliferative retinitis, or in free collections of mononuclear cells lying on the surface of the retina. The two appearances are sometimes closely

correlated, though not always so. It will be remembered that Straub laid great stress on the presence of more or less sharply defined dots on the back of the cornea, on the retina, on the lens capsule, and on other surfaces. These dots he found to be due to aggregations of leucocytes, which he considered were attracted to the spots where they were found by chemotactic action. A comparison of Straub's illustrations with those here given (Figs. 23 and 24) will show a close similarity between the two. He hypothecates the impregnation of the membrane attacked with the substance possessing chemotactic influence; this substance is spread over the surface and attracts leucocytes to it. Where the leucocytes are killed, owing to the intensity of the poison, fresh cells are attracted by the chemotactic influence of the dying leucocytes, and thus the slight inequalities of the first formation become exaggerated and give rise to the formation of the small heaps we have been discussing. This ingenious theory helps materially to explain the phenomena we have observed in these cases. Not the least significant fact in this connection is that in the cases we are now considering the brunt of the trouble appears to be borne by the retina, whilst the choroid almost uniformly escapes. (3) The deposition of inflammatory material may cause an infiltration and thickening of the anterior layer of the hyaloid. It is well known that the vitreous body is more firmly attached to the retina in the neighbourhood of the ora serrata than elsewhere, and the contraction of an inflammatory membrane in the anterior part of the vitreous will pull throughout its whole circumference on the retina in this neighbourhood, thus effecting a wide detachment of the anterior portion of the membrane. Our specimens illustrate this point well. (4) When the lens itself is the principal focus of the sepsis introduced, as it obviously often must be, the inflammatory action set up causes the formation of radiating bands from the lens-remains into the surrounding parts. The contraction of these bands will act powerfully in effecting retinal detachment. It is true that in a number of the cases an abundant subretinal exudate can be seen to have been present, but it seems obvious that this was in no way causative of the detachment. It was simply an effect of it.

To summarize our conclusions: An examination of these fifty-four globes removed after couching throws some light on the problems so ably studied by Straub, but lends no support to the view that the changes met with in such septic cases justify the assumption of the existence of a clinical entity to which we can give the name of hyalitis. Septic matter introduced into the vitreous is probably rapidly and widely diffused throughout the structure, and in so doing there is reason to believe that by chemotactic action, it may attract inflammatory material from the ciliary body and from the optic nerve head into the hyaloid

substance. It would seem also that it has a similar action on the retina, and possibly on the choroid as well, though of the latter the evidence is scanty. A far more important element is the septic infection of the ciliary body and of the retina and choroid at the time of the introduction of a septic instrument; in other words, it would seem likely that the changes found in the vitreous under these and allied septic conditions, are mainly to be attributed to cyclitis, and to a lesser degree to choroiditis and retinitis, it being understood that these changes are primary, that is to say, caused by sepsis introduced into those structures themselves, and not secondary, as Straub implied, to changes set up in those bodies by the chemotactic action of septic material distributed throughout the vitreous. It would be of the greatest interest if a series of experiments could be undertaken for the introduction of a deposit of septic material within the vitreous, without contamination of the tunics of the eye. The technique might be difficult, but with mechanical appliances, the difficulties should not prove insuperable.

Straub's paper dealt with the results of septic infection of the vitreous. Our material has enabled us to trace the same processes wider and further by virtue of the greater number of globes concerned and of the greater variability of the elements entering into them.

There are two factors to be taken account of in every one of these cases: (1) the stab-culture of the vitreous body and (2) the simultaneous infection of the surrounding vascular coats.

Our series furnishes no evidence in favour of the formation in the vitreous body of localized cultures of organisms, such as Straub alludes to. On the contrary, everything goes to show that the virus is early and evenly distributed by difiusion throughout the vitreous body. Under such conditions, it would appear to give rise to chemotactic action, as described by Straub. The brunt of that assault would appear to fall on the retina.

The formation of the characteristic exudate within the vitreous would appear to be very largely accounted for by the infection of the vascular tunics of the eye, and by the results of their inflammatory reaction to that infection. On the other hand, the even distribution of the exudate throughout the vitreous would appear to suggest the possibility that the septic matter within that body acts chemotactically upon all the surrounding structures throughout the extent of their contiguity with it and not least upon the ciliary body.

With regard to Straub's advocacy of the term "hyalitis," the academic view undoubtedly is that the vitreous is an inert body, that the real site of the inflammation is in the vascular structures surrounding it, and that the nomenclature adopted should make these points clear.

Straub, in support of his argument, cites the customary use of the term "keratitis," as a precedent for speaking of "hyalitis." The

fact that our specimens show new formed blood-vessels in the inflammatory tissue within the vitreous of certain of these eyeballs lends some support to such a contention. The conditions are, however, not quite parallel, the lymph channels in the cornea being, under normal conditions, more definite than those in the vitreous, where the process of nutrition is conducted by osmosis rather than by lymph flow. The vascularization of the cornea takes place much more readily in its more highly organized structure than does the same process in the vitreous. In the end, however, the difference would appear to be a matter of degree rather than of kind.

So long as those who use the terms understand exactly what they mean, little harm can be done, but, isasmuch as those terms will be transmitted to students and to many others, whose comprehension of the position will not be clear, it seems a pity to use the term "hyalitis."

The appearances so constantly observed in the vitreous, taken together with those found in several of the optic nerves, would seem to lend strong support to the view that some, at least, of the lymph from the eye takes a backward passage and escapes by channels in, or in the neighbourhood of, the optic nerve. This phenomenon serves to explain the occurrence of optic neuritis as a complication of septic wounds of the anterior segment of the globe.

FACTORS IN STEREOSCOPIC VISION AND IN THE VISUAL ESTIMATION OF DISTANCE

BY

E. M. EATON, M.D.,

CAPTAIN R.A.M.C.

THE power of estimating distances with accuracy is essential to expertness in handicraft, in sport, and in any activity which controls the direction or the amount of a mechanical action.

In every department of life, therefore, this faculty is of importance, directly or indirectly; yet, owing to its very general possession and to its susceptibility of improvement according to the requirements we habitually make of it, the limitations and the illusions to which it is subject are readily overlooked. In few judgments are we more dependent on familiarity of circumstances and setting than in this one. The question is one which has assumed a peculiar importance in recent years, when so many men accustomed to living indoors have been transferred to a life in which visual judgments in the open are constantly called for,

and when for the first time the art of flying has become an achievement of far-reaching consequence.

Stereoscopic vision—literally solid vision—has since the time of Wheatstone been commonly accepted as a specific function of the visual apparatus whereby we appreciate solidity in space as a result of fusion of the dissimilar images formed on the two retinae. This view received much of the stability of its acceptance through the writings of Hering, who regarded stereoscopic vision as a congenital property of the visuo-psychic apparatus.

While the nativistic theory has never been widely accepted, the general view of the essential nature of solid vision is seldom seriously questioned. On the other hand, the belief that a single eye gives a certain amount of appreciation of three dimensions, to the degree, at any rate, which is often referred to as the "sense of depth," is surely general; and the opinion which I shall advocate that this ought rightly to be included in the term "stereoscopic vision" is not new; it is implied in the existence of such instruments as uniocular stereoscopes and binocular stereoscopes for use with a single picture.

So far as I am able to conceive a difference between the "sense of depth" and the "sense of solidity," it is merely this, that the former is more realistic in reference to the intervals between objects, and the latter in reference to the objects themselves. Even if such a differentiation did tend to occur, however, the composition of most views demands that if the one is observed so also is the other. In no type of vision, except in specially arranged illusions, do we see the further parts of an object detached from the nearer ones, a state which would follow if we perceived depth without solidity. The difference is one of sentiment rather than of perception; the sense of depth gives a wet atmosphere picture, the sense of solidity a bright one.

There are other means than the fusion sense* whereby we perceive solidity through vision. Apart from fusion, I would include five factors as being of the first importance, and generally available. The chief of these is the shape of the retinal images of symmetrical objects or of objects of whose real shape we have some other means of gauging; what, in fact, is generally understood by the term "sense of perspective." There is alteration of definition according to distance; there are the lighting effects; in the case of very near objects there is the sense of ocular convergence; and, if the

* In order to avoid ambiguity, I shall use the term "fusion sense" in place of "stereoscopic vision," to denote the specific contribution of binocular vision to the sense of depth or solidity; it will, therefore, not be interchangeable with the term "fusion faculty," which describes a function that is antecedent to the fusion sense thus defined. "Stereoscopic vision" will be used in the less restricted and less conventional, but, I think, not less legitimate, meaning of the visual sense of solidity, however engendered.

observer is moving or should move his head, there is parallax. There are also others of lesser value and more occasional occurrence, such as atmospheric interference; and many incidental evidences, as, for example, the manner in which a cloud of steam may be broken as it passes through a group of trees, thus giving information concerning the relative position of the obstructions. In addition there are several important accessories, but notably the muscle sense, which, in so far as it acts as an informant of the position of the eyes relatively to the body, or of the distance through which a head movement has been made for the observation of parallax, ought to be grouped with the sense of convergence as an extension of the sense of vision.

Although these factors assist in the recognition of depth, it would none the less be unjustifiable to describe them as means of stereoscopic vision if they gave us merely knowledge of solidity, but failed to give us that quality of visual feeling by which from sensation alone, without conscious reference to intellectual knowledge, we become aware of the third dimension. If, however, they or some of them should give us this quality of consciousness, I think it illogical to reserve the term "stereoscopic vision" for the vision obtainable by any one particular means. It is objectionable on other grounds also; it may lead us into fallacious deductions. The sense of depth obtainable from fusion is an art acquired by experience no less than is the sense of perspective, and it is a much less fixed character of our visual functions. If the same art can be acquired without the aid of fusion there is no reason to discriminate.

To my mind a one-eyed man sees stereoscopically in the only valid sense of that word. He will always say that he sees things solid, not flat, and his achievements support his belief. It is a common experience that a woman who has recently lost the sight of an eye will pour tea from a pot upon the table cloth beyond the cup that she intends to receive it; but after a little while she becomes perfectly efficient in the matter. She learns to pay more attention to, and to place more reliance upon, the other checks of the accuracy of her solid vision.

If we look at an ordinary pair of stereoscopic photographs and, without removing the instrument, cover one eye, we shall find that we still see stereoscopically. There is a certain loss undoubtedly, we lose half our illumination, and we may feel that solid vision is not of so great a realism as it is with the two eyes.* This improves with practice and effort, however; in such an experiment we are in the position of the woman, of whom I spoke, on the very day on which she loses the sight of her eye. If we look at the people and objects

* This loss is much less if an optically correct stereoscope is used. The stereoscopes ordinarily sold are correct neither in focal length nor in prismatic strength, and the photographs sold with them are made with an exaggerated distance between the lenses.

around us, and then cover one eye, the view does not become flat. It is true we lose in the accuracy of relative judgment of distance, but we do not lose the sense of solidity; in fact, if synchronously with the covering of one eye we bring the other eye into the position formerly occupied by the middle of the interocular space, so that the line of projection will not be altered, we shall have difficulty to discover any modification of the visual impression. The fusion sense is not an essential factor in stereoscopic consciousness, and I think I shall be able to show that it is not the dominating factor.

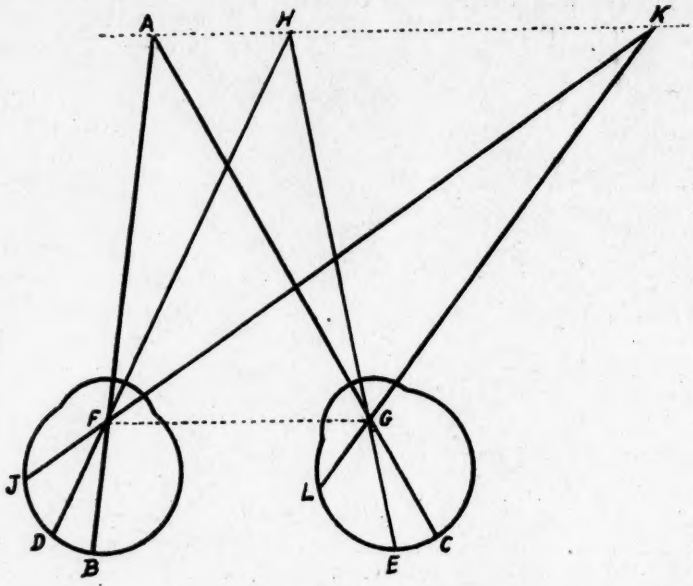

FIG. 1.

A glance at the theory of the fusion sense will indicate something of its potentialities and its limitations. The classical theory of corresponding retinal points is still useful, although in some respects it cannot be accepted rigidly. When the visual lines are parallel, that is, when vision is fixed on a distant object, light from the point of fixation will fall on the two foveal centres, and the rays from any other distant objects will fall on points of the two retinae, which form at the respective nodal points of the eyes, with the lines of vision, equal angles in parallel planes. Such points on the retinae are known as corresponding points. Now, if the eyes converge to fix a comparatively near object its images will fall on

the maculae and the images of all other objects in the same plane would, according to the original theory, fall on corresponding points. The plane of the objects fixed was known as the reference plane or basic plane, for that particular position of the eyes.

To say that the images of points on the reference plane fall on corresponding points on the retinae is true, however, only for a very limited field, strictly true in fact only for distant objects; the images on the periphery of the binocular field are double even for one plane.

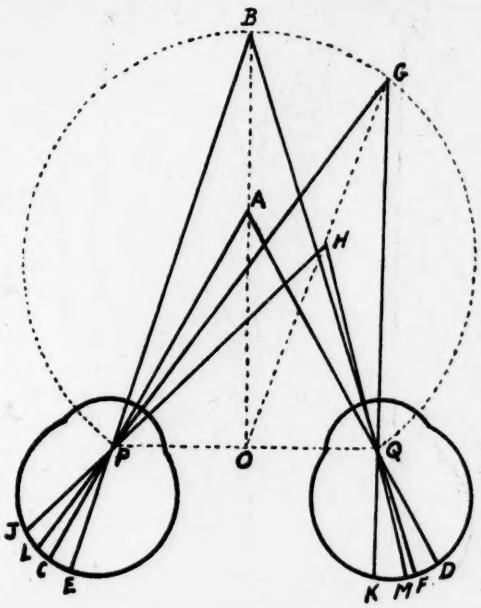

FIG. 2.

If in the accompanying Fig. 1 A is the point of fixation and B and C the two maculae, D and E will be corresponding points according to the definition if $\angle CGE = \angle BFD$. But $\angle CGE$ will equal $\angle BFD$ only if $\angle HGA = \angle HFA$. The further H is displaced laterally from A, for example to the point K, the less is this true. and if the binocular field reached out to 90°, which of course it does not, the difference on the periphery of the field would equal $\angle GAF$, which is twice the angle of convergence and is therefore a very large angle when we are looking at near objects. To overcome this difficulty, it is necessary to postulate that the surface of reference should be circular in section; this circle which passes through the

point of fixation and the nodal points of the two eyes, is known as the horopter; the successive reference surfaces, as the point of fixation approaches to the observer, will therefore be, in section, gradually diminishing circles which, obviously, cannot be concentric.

Continuing, however, if an object lies beyond the reference surface its images will fall to the nasal side of corresponding points, and if it lies nearer than that surface, they will fall to the temporal side. The amount of the dissociation will determine our estimate of the advancement or recession; it is really an unconscious

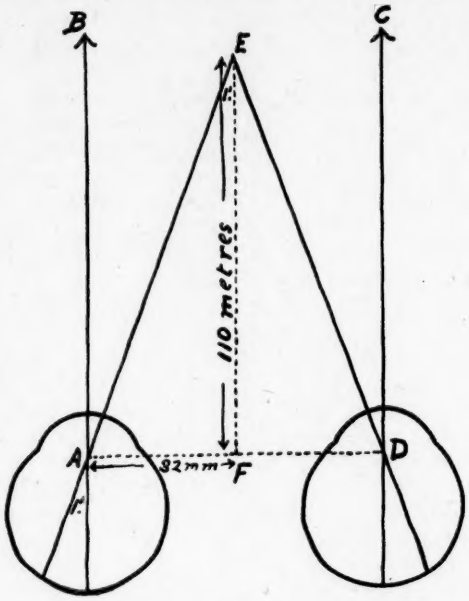

FIG. 3.

A B, D C. parallel lines of distant vision; F E, line of binocular projection; E, furthest point on this line giving appreciable angles at A and D.

measurement of this angle that provides the means of our fusion sense judgment. The relative positions are shown in figure 2.

It will be observed that if the eyes fix the point B, E and F being the maculae, the images of the point A fall to the temporal sides at C and D. Light from any other point in the horopter of B, such as G, falls, as we have seen, on corresponding points, which let us call K and L; again, light from any nearer point along the line O G will fall relatively towards the temporal sides, those of H falling at the points J and M.

Our power of measuring this angle of dissociation is of a very high degree, so that within the limits of distance that will afford an angle appreciable by any means short of the finer types of mathematical instruments, our fusion sense will be effective, provided, however, it is not interfered with by other influences. This is demonstrated in the old experiment of Hering's, of dropping beads on either side of a stretched thread, which is observed through a narrow funnel.

Visual acuteness of 6/6 is such as will enable us to distinguish two points if the distance separating them subtends an angle of one minute. It is approximately the minimum angle which permits of the stimulation of two retinal cones leaving one cone unaffected between them. Assuming this standard of vision and an interocular distance of 64 mm., an appreciable dissimilarity of images in the two eyes could occur, theoretically, up to a distance of 110 metres.

Beyond that plane the dissociation on the retina would not be such as to make differentiation anatomically possible. Our fusion sense, therefore, cannot play any part at distances greater than 120 yards, and in actuality it probably ceases to be effective at a considerably shorter distance; for points which do not fall on the maculae it necessarily fails at a much nearer plane. It is therefore of very limited range. It is also of very defective stability.

If a pair of stereoscopic photographs be reversed so that the left-hand card is seen before the right eye and vice versa, the view should be reversed in the third dimension, making objects in the foreground appear in the distance. This, however, will not be found to occur. It will sometimes be felt that a struggle is taking place, and a massive or obtrusive object in the foreground may sometimes momentarily move out of position, but in general the picture retains its original character. The other factors in stereoscopic vision dominate the fusion sense.

This experiment was referred to by Dr. I. Franklin in a paper published in the *American Journal of Ophthalmology* of April, 1918. Dr. Franklin's conclusion is that the picture is reversed, from which he argues the importance of seeing an object from two points of view, but he opposes the theory of stereoscopic effect being due to the fusion of dissimilar images as ordinarily accepted. The reversal to which he refers, however, must be the movement of a prominent object to which I have referred, for no ordinary composite view will be found to reverse against the evidence of the sense of perspective. When a massive object in the foreground moves to the back, it does not do so in accordance with any system of order, it is merely lifted out of the picture, that is it ceases to have any relation to the perspective projection of the view as a whole. This anomaly would less readily occur if the pictures were not made with an exaggerated displacement. Experimental pictures of symmetrical objects, such

as cones and hemispheres, which are so arranged that the anterior and posterior perspective projections are acceptable, will, of course, reverse completely.

If we reverse the card top to bottom and right to left, that is by simple reversal without altering the original relationship of the two halves, the fusion-sense acts normally; but owing to the unusual view, the sense of perspective and the appreciation of shadows are almost wholly in abeyance. If now the two views are transposed, right to left and left to right, the fusion sense will have free play and immediately, being relieved of conflict, will carry the foreground into the distance, and distant objects will come forward. If there be a figure of a man shown in front of a building it will be found that there appears a clean cut hole in the wall exactly of the form of the man, and in the distance beyond will be seen the man himself. After some study the sense of perspective may begin to apprehend the inverted picture; if so it will again assert its dominance. The second part of this experiment has a particular value in eliminating the question of the assistance of intellectual knowledge which might be held to account in part for the maintenance of the normal relationships in the former method. In this case reversal occurs despite the fact that the observer is aware of the physical impossibility of the apparent relative positions.

Our fusion sense, therefore, appears to be extremely elastic and readily capable of compromise or even suppression; it works hand in hand with the other means of stereoscopic vision, giving and taking as may be most convenient on the occasion.

A painted picture does not appear to us flat, yet our fusion sense ought to make it so, for the two retinal images are similar. There is a feeble effort in this direction, however, and unless we are accustomed to suppressing this, we shall get better relief with one eye. Our experience is that things that appear of the form we see in the picture are not flat, and our sense of perspective indicates the varying degree of relief. It is, of course, possible to look at the canvas and paint as such, and see a flat surface; but that is another matter. The effect becomes more realistic if we examine an ordinary photograph in such a way as to get full value out of its perspective. Viewed in the usual way, the perspective of a photograph is truthful only in an objective sense. It is as though we were looking at a picture of a man viewing a landscape, and what is represented is what this man sees. We may project ourselves into the position of the man, and the perspective will be correct so far as intellectual considerations go; but in order to have his visual consciousness, we must be where he is, that is where the camera lens was; it is to this point that the lines of the picture converge, it is the centre of projection. The ordinary pictorial postcard is made as a rule with a lens of 5 inch focal length, and with the plate in the principal

focal plane; it should, therefore, be held at 5 inches from the eye; in that position we shall see it directly, we shall see it as though we ourselves were looking at the scene, not as though we saw someone else looking at it. We therefore see it in a real sense, there is no conscious mental process intervening between our visual sensations and the feeling of the presence of the objects depicted; in consequence we see stereoscopically. To focus for 5 inches we shall require a lens, and as we are going to believe ourselves looking at a distant scene, our accommodation should be relaxed. A + 8D. lens

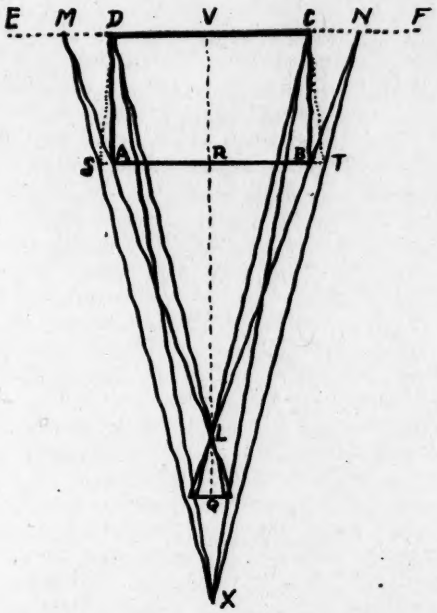

FIG. 4.

will therefore be required in addition to our distance correction if one is worn; the card should be held at the furthest position affording clear definition. Only one eye must be used, as it is essential that the point of observation be opposite the centre of the card.

The means whereby perspective gives accurately a sense of depth, and the reason why it is advantageous to view a photograph from the focal distance of the camera lens, will be made clear by the accompanying figure.

If A B C D is a rectangular building of depth R V, 20 feet; L a

camera lens 40 feet in front of A B; E F an imaginary screen immediately behind the building; then M N will represent an enlarged and re-erected image of that on the camera plate in the ratio V L : L Q. As viewed from L the image of the wall D C is not enlarged; but A B appears as M N, enlarged in the ratio L V : L R, i.e., 60 : 40 or 1,5 : 1. Now L is the only position from which the points M and N on the screen can be seen along the lines L M and L N on which the positions of A and B lie. If viewed from X the points A and B must be referred to positions on X M and X N, such as S and T, and the building will no longer appear rectangular, but have the form S T C D. We know, however, that it is rectangular, for, while an individual building might have a freakish shape, the mind will not accept the suggestion that chimneys, windows, doorways, and all are built skew. Yet memory of form is insistent, and the reconciliation is found in our taking an objective view of the picture, including the observation point L; we consequently lose the sensation of the extension of the scene in space before us. If we regard the camera as an eye looking at the building, the image M N will now represent an enlarged and re-erected image of that on the retina. The proportions M N : D C being 1,5 : 1, determine that L V : L R is also 1,5 : 1, an accurate interpretation of the stereoscopic relationship of D C to A B.

If the objects of view be circles a greater accuracy of form judgment is required in making a correct interpretation, but it is still very easy. With the miscellaneous objects, such as trees, houses, or men, found in an average composite view, our sense of perspective remains the most important of the purely visual calls for stereoscopic consciousness, although not necessarily the most accurate informant for stereoscopic judgment.

Unlike the fusion sense, the sense of perspective has no natural limit to the distance within which it acts. Accuracy of perspective judgment is dependent on the form sense and the form memory. To use the same terminology as for light, the form sense here required might be described as the form difference as distinguished from the acuteness of vision which is the form minimum. The perception of form, and therefore also the sense of perspective, in a broad angular field involves not only visual impressions, but also impressions of ocular movements.

In judgment of distances we have instinctively a greater confidence in determining the relationship to imaginary straight lines drawn transversely in front of us, through the successive points of fixation, than in estimating relative radial distances, that is, positions in relation to concentric circles around us; least of all could we suggest a relationship to any horopter. This fact fits more easily into the scheme of a perspective estimate than of a fusion one;

but, however that may be, the important point is, that in practice the reference surfaces for our composite stereoscopic vision are flat.

The next factor in stereoscopic vision is gradation of definition. If we look at a landscape with trees, houses, and other objects, we shall observe of the trees in the foreground the gnarled surface of their bark and the veined structure of their leaves, while of the houses we may discern the manner in which the stone is finished, and many other details. A little further off we can just discriminate separate leaves, and we still see the outlines of the blocks of stone in the house fronts. Further off still, the trees are represented only by their general outlines and by their colours.

An interesting light on the importance of the progressive definition of detail is given by its influence in stereoscopic radiography. This is the chief respect in which skiagraphy fails to produce an optically correct representation of reality, and it proves a serious defect where the structure of the object is finely meshed. Unlike that of a photograph, the detail of a radiogram improves as the distance of the things represented increases, for the further parts are nearer to the plate. If a stereoscopic pair of radiograms be made, showing a hand with outspread fingers lying obliquely at about 70° to the plane of the plates, it will probably be found quite impossible to get a stereoscopic impression, so persistently does the definition demand that the finger which is best defined be brought to the front of the picture.

In our estimates of distance when looking over a plain or over the open sea, definition is of the greatest importance; no index remains to our judgment but the texture of the undifferentiated carpet which stretches in front of us.

Gradation of definition as an aid in stereoscopic vision varies in effectiveness according to the acuteness of vision of the observer.

The sense of convergence is active at close distances only; but in the stereoscopic view of more distant objects, the determination of our relationship to near ones is essential. Of this I shall speak later. The great influence of convergence on our judgments at close range is observable in the use of the Wheatstone stereoscope. While keeping the photographs at fixed distance, if we move the mirror back and forward the effect is to make our eyes converge and diverge. Although the images subtend practically constant angles, they diminish as the mirror is pushed back, and appear larger when it is pulled forward, for our subconscious estimate of distance is altered; the illusion is analogous to the apparent variation of the size of the moon, which, when it first rises and looks as if sitting on the horizon, seems larger than when it comes overhead and appears but a little above the clouds. The same experiment demonstrates our greater sensitiveness to convergence changes than to the absolute

degree of convergence, as the illusion is more vivid while the movements are being made.

Lighting effects afford very definite information, which is especially marked if the light is direct like that of the sun on a bright day, or of the moon or the artificial light by night. Where I sit when writing, if I close one eye, the shadows cast by some picture cords opposite compel me to recognize the distance of the cords from the wall. By expelling from the mind the association of the shadows with the cords, I can project the latter back to the wall, but until this is done the effect is undoubtedly and inevitably in relief. The varying density of the shadows in the folds of a heavy plain curtain at my side give a more accurate appreciation of the form of the curves than even binocular vision does on a part that is fully illuminated.

These are simple cases where the shadow effect is acting alone, but in more complex views shadows have generally an important part; it is noteworthy that in outdoor scenes weather relationships commonly determine that as we lose in shadow assistance, we gain in the value of atmospheric interference. In our interpretation of shadows we are to a large extent dependent on experience, more especially of the habitual interpretation of the effects of parallax; for the rest, our sense of light difference is put to test.

The last of the major factors in stereoscopic vision which I shall mention is parallax itself. If with one eye closed and from a horizontal elevation we look at a number of plain opaque cylindrical vessels, such as earthenware flower vases, set out on a table, our stereoscopic guides will be almost entirely eliminated and our sensation of depth will be poor or absent. Our judgment, if not one of flatness, will, at best, be hopelessly fallacious. If, now, the head is moved laterally an immediate improvement occurs, and what may have been a flat view suddenly stands out in relief. The effect of parallax as presented to us whilst travelling by train is familiar; it would be hard by any effort of will, however complete might be the exclusion of other stereoscopic aids, to flatten out a view bearing such unmistakeable evidence of varying depth. Probably most persons have avoided the unpleasant sensation of this view to an extent which has prevented their acquiring it as a direct factor in stereoscopy; it still acts through a conscious interpretation. It might therefore be said that it is not legitimate to regard such a condition as an element in stereoscopic vision. This, however, may or may not be true.

In considering alter 'ions of a state of consciousness brought about by external stimuli, it would surely be artificial to separate off such modifications of the resultant as arise from necessarily associated internal conditions. Were we to do so our vision would be meaningless.

Thus it is that in stereoscopic vision, as in vision as a whole, previous knowledge is the greatest of all factors. Our strongest incentive to the introduction of a third dimension into a view is not directly visual, but is the belief that solidity exists in it, that it would be incongruous to believe it otherwise in the conditions observed. When we have once been convinced of the existence of the third dimension in a scene, the question whether we see stereoscopically is purely a psychic one; if the knowledge passes to subconsciousness and yet retains its influence on our visual concept, then we actually do see stereoscopically. The relationship is the same in the sphere of perception as consciously controlled action is to acquired reflex in the sphere of motor function. In each case the subconscious is the later development and the more reliable condition; in each case it is acquired by custom and correspondingly it may be improved by training.

Of the sensory factors which contribute to stereoscopic vision, the relative influence varies with persons and with circumstances. Not always does the one which most strongly compels the sensation of depth give the greatest accuracy in determining its amount. For average conditions I should place them in order: perspective, fusion sense, gradation of definition, convergence, lighting, and parallax. In special cases parallax would occupy a much higher place. Straub first claimed that he could see a swollen optic disc in relief after observation of its parallax. It is doubtless a common acquirement, although perhaps not always realized by those who possess it; but it is a valuable means of measuring variations of the disc and is worth attention, physiological cups being good material for observation. In this case parallax is the chief guide, but perspective, definition, and lighting have also an influence.

My reasons for considering the fusion sense inferior to the sense of perspective are that it is more easily deceived, that its range of action is much more limited, and that acceptance of its guidance is much less imperative. The tests on which we are apt to appraise the value of binocular as compared with uniocular vision are experimental ones in which the index of dissimilar images is put to its greatest advantage, and the guides to the single eye are designedly excluded. As an indicator of the relative general value of the two functions it would be no more ludicrous to make an experiment of a converse type, and to compare the uniocular impression of a series of transversely stretched wires of which the lateral attachments were visible, with the binocular impression of the wires alone, as seen through an aperture in a screen. In everyday life our vision is rarely without perspective aids, but much of what we look at is beyond the range of dissimilar images.

In general it may be said that each function acts as a check on and reinforcement of the others where their ranges overlap, and as a

complement where the limits of action of one or another fall short. All are capable of making compromise, the fusion sense and the sense of convergence most readily. Each factor acts to greatest advantage if the conditions in relation to it correspond to habitual experience.

Whilst stereoscopic vision involves the subconscious estimation of relative distance it does not necessarily follow that it implies any estimate of absolute distance. It is true, as we have seen, that every view has a definite relationship to the point of observation; the lines of perspective converge upon it, and if it is a short range binocular view the relationship could be calculated also from the dissimilarity of retinal images. Owing to the smallness of the angles, however, the subjective relationship determinable in this way is very inaccurate; while on the other hand, relative distances are appreciable in a high degree. But we are not dependent for the knowledge of our subjective relationship upon a single stereoscopic view. Only exceptionally is our vision fixed for more than an instant on one spot, and as fixation moves the reference surface changes. If we are approaching some definite point in space, as in drawing up a motor car at a door step, we have certainly a principal fixation point; but our relationship to it is changing and therefore also the horopter, and still more markedly all of our perspective ratios are continuously altering. Our conscious relationship to the external world is determined by the composite result of a potentially infinite series of stereoscopic pictures lying between the furthest and nearest planes for which we fix, together with a knowledge of our relationship to those fixation points which fall within a comparatively short range; therefore if we have no available foreground our distance estimates will be poorer.

How is the last link filled in between the nearer reference planes and our eyes? All our stereoscopic factors are at a greater advantage, it is true; but while that may assist I do not think it does so to any great extent. It is here that the muscle sense becomes of great importance. The ocular convergence comes into action, a function to the sensitiveness of which reference has already been made. If we should be standing on the level, the amount of depression of the visual lines in looking at an object on the ground, taken together with our own height, gives the data for the solution of a triangle, which custom reduces to a simple perception. Were we sitting in a motor car the radiator cap or the tip of the mud-guard would fix the position of the chief of our near hand reference planes; in making judgments from the bridge of a ship it would be the stem of the ship or some part of the rigging; such points of accustomed reference as these acquire an important value. In estimates of this kind everything that determines our sense of equilibrium and our knowledge of the

position of the head and eyes also plays a part. The visual angle subtended by objects of known size is a factor of some importance, especially for objects lying in the peripheral parts of the field where most of our aids are at a disadvantage. The information obtainable from the act of accommodation, apart from convergence, is, on the other hand, practically negligible. It is possible to say which of two very near objects requires the more accommodation, but we cannot estimate the relative amounts.

It is noteworthy that in the majority of the practical applications of our estimate of distance we are concerned not with the naming of so many yards or inches, but in the judgment of the relationship of the effect of some proposed action to the space within which it is required to operate. If these judgments are carried out subconsciously the attention is free, as it should be, for the observation of variable factors alone; and, moreover, co-ordination is more rapid and less liable to confusion than if directed consciously.

The subconscious judgment of distance in this sense is but an attribute of the function of stereoscopic vision in the more extended meaning; when the eyes and mind are familiar with the circumstances amidst which for the time being they act, the judgment of distance becomes reduced to a simple sense perception.

The inferences that I would draw from these observations are:

1. That stereoscopic vision implies and, from its nature, is coextensive with the subconscious judgment of distance by vision.

2. That the potentiality of the individual for reliability in distance judgment must be gauged by considerations which include:—

1. Form sense.
   - *a.* Acuteness of vision.
   - *b.* Form judgment (form difference).
   - *c.* Form memory.
2. Fusion sense.
3. Convergence sensibility.
4. Light sense.
   - *a.* Light minimum.
   - *b.* Light difference.
   - *c.* Colour sense (in special cases),

5 Muscle sense.

6. Aptitude in visual observation.

3. That persons with defects which reduce the efficiency of the fusion sense, or throw it out of action, although deprived of a great asset in stereoscopic vision and in the judgment of distance, lose in degree only, and therefore may, by training, compensate in great part for the deficiency.

In discussing the nature of stereoscopic vision and the power of judgment of distance, I have not attempted to do more than

indicate the elements of which I conceive these faculties to be made up, and to suggest the probable order of their influence. The assigning of relative values to the various factors and the determination of their modifications according to circumstances whether of environment or of ocular conditions, are points upon which the many important practical bearings of this subject will depend.

REPORT ON OPHTHALMIC CASES IN EGYPT, 1915

BY

SIR JAMES W. BARRETT, K.B.E., C.M.G., M.D., M.S., F.R.C.S.(Eng.)

LIEUT.-COLONEL R.A.M.C.

THERE appeared in the August, 1917, number of this Journal valuable reports on the ophthalmic work done in Egypt in January, 1916, of the period Lieut.-Colonel Eason, C.M.G., Consulting Oculist, E.E.F., and from Major F. Lockhart Gibson, A.A.M.C., who was at Mudros in the latter part of 1915, and in Egypt for part of 1916. Both of these reports relate to the period when the work in Egypt was well organized, when appliances were freely obtainable, and when medical assistance was abundant.

1. I propose to complete the story by describing the ophthalmic work in Egypt during the period of improvisation, viz.: from the beginning of 1915 until November of the same year, when I was invalided out of Egypt. The actual work began about January 24, 1915, at the First Australian General Hospital, Heliopolis, where an ophthalmic and aural department was opened, to which patients speedily found their way. As there was no ophthalmic or aural surgeon available in Egypt at the time, I was appointed consulting oculist (and aurist) to the Force in Egypt, and the greater part of the work was done at Heliopolis. As the year passed by, oculists began to arrive in Egypt, and decentralization was gradually effected. The staff at Heliopolis usually consisted of two or three assistant surgeons, one medical student, and two nurses in the out-patient department, with the use of a ward of 100 beds. The assistant surgeons were mainly Captain Morlet, Captain Rosenfield, Captain Stevens, Captain MacLellan, and Captain Burke, A.A.M.C., and Mr. Cook and Mr. Wharton, medical students. The clinique was available, and utilized freely by British, and New Zealand, as well as Australian troops. In passing, it may be said that the work was very extensive and heavy, and that there was a considerable amount of operative work after the Dardanelles landing.

2. As regards the nature of the diseases treated, the results were a surprise to those who, like myself, had no previous experience of military work. Of the ophthalmic cases, half were cases of ophthalmia, principally of the Weeks's variety, with a smaller percentage of diplo-bacillary cases. There were only five cases of gonorrhoeal ophthalmia during the whole period, a most remarkable circumstance when the frequency of venereal disease is considered. Errors of refraction comprised nearly 40 per cent. of the cases, so that the cases of ophthalmia and refraction constituted the greater portion of the work; 90 per cent. in all. There were very few cases of trachoma, and nearly all of them came from Australia. It is not a little remarkable in a country where trachoma is so exceedingly prevalent as Egypt, that practically none of the soldiers contracted it. The circumstance throws a flood of light on the supposed contagious nature of trachoma amongst Europeans, and, incidentally, on the legislation adopted in the various countries with regard to persons suffering from trachoma.

3. After the landing at the Dardanelles, a fair number of injuries made their appearance, and a considerable number of eyes were excised. A few operations were performed for cataract and the removal of foreign bodies, and in a number of cases projectiles were removed from the orbit. One death occurred after the removal of a projectile from the apex of the orbit, and, after death, a second bullet was found in the brain. Many of the eyes which were excised had not been directly injured; in some cases the projectiles had not passed within an inch of them, nevertheless the internal coats were torn, and the eyes hopelessly disorganized. Whether this arises from the velocity of entry of the projectile, or from its rotation, we were unable to decide, but the cases were fairly frequent, and the conclusion certain.

4. *Removal of foreign bodies.*—Many of the foreign bodies in the interior of the eye were non-magnetic, and the eyes were hopelessly disorganized. The large magnet at Mansourah, which is under the control of the Public Health Department, Egypt, was placed at our disposal, but few cases made their appearance in which its use was necessary or of service.

5. *Shell shock.*—Of genuine shell shock cases, i.e., shell concussion, we saw a few cases. Men who showed no sign of external injury complained of defective vision in one eye, and showed haemorrhages into the retina. Whether these were due to direct concussion, or, as Dr. Mott suggests, to gassing, I do not know. They were not common, but there were a few definite cases. The remaining so-called cases of shell shock were, when genuine, obviously cases of hysteria, and there were very few of them. A common type of case was the man who screamed at the light, turned his face to the pillow, and closed his eyes violently; and of

these cases nothing more need be said than that their recovery was usually a matter of a day or two.

6. *Malingering.*—A fair number of malingerers made their appearance at first, and gave a great deal of trouble by reason of the elaborate examination that such cases necessitated. As soon, however, as they realized that an expert department had been created in Egypt, the numbers fell off, and the numbers ceased to be of any great importance. There is, however, a type of case much more difficult to handle than the true malingerer, viz., the man with a tendency to neurasthenia or hysteria, who exaggerates his symptoms, and who is subconsciously endeavouring to prove that he is really worse than the medical officer thinks he is. This singular nervous mixture is sometimes very difficult to deal with. There is no sharp line to be drawn between the element of fraud and the element of nervous demoralization. However, difficult as the problem may be, I am quite convinced that the only mode of treatment which is effective is that based on the absence of morbid sympathy, and based directly on the induction of a normal morality. In these cases the sympathetic lady visitor is apt to be highly dangerous. In such cases, when a complete examination of the eyes showed that there was no disease of fundus or media, and the error of refraction was simple, we disregarded altogether the man's statement respecting his accuracy of vision and discharged him to duty after a reasonable rest, and I think I can say with confidence that in not one single instance was a mistake made.

7. It must be remembered that in the early part of 1915 the issue of spectacles to the men had not been authorized, and arrangements were made at first, whereby the men could purchase their own glasses at reasonable rates from opticians in Cairo. Later on, the War Office authorized the issue of spherical glasses. By this time, all concerned had become aware of the fact that it is useless to order glasses for men in the field, unless their vision is considerably improved by their use. It also became obvious to those who watched the work, that high standard vision is not required of modern soldiers. Those who have rendered themselves artificially myopic, as I have done, for the purposes of investigation, will be surprised to find how much they can see in the way of common objects with a vision of 6/24ths. I published an account of an investigation of the kind I made in connection with the visit of the British Association for the Advancement of Sciences to Australia in 1914. So far as mariners at sea are concerned, the real danger of defective vision, that is a vision of anything below 6/12, is the reduction of the colour-sense which follows. 6/12 form vision would not materially interfere with the activities of people in most occupations, but 6/12 vision or less for pilots or

engine drivers may be a serious matter, because of the great reduction of colour perception with which it is associated. In the case of the ordinary soldier this condition does not arise, and there is no doubt that standards of visual acuity set in the past have erred on the side of stringency.

8. *One-eyed men.*—It was decided in 1915 to invalid out of the country men with only one eye, because of the supposed risk to the other eye from ophthalmia. We have since learned that the risk of losing an eye from ophthalmia in Egypt is negligible. The policy of sending one-eyed men to the front was dealt with by the Army Council subsequently, but a one-eyed man runs very little more risk of losing his eye in Egypt than he does in England, apart from the risk of active service. He may, it is true, get odd attacks of irritation from the dust, but of serious ophthalmia there is very little risk. One remarkable case came under notice: an Australian who had lost one eye from detachment of the retina determined to go to the Dardanelles. He eluded authority, and got to the Dardanelles, was injured in the blind eye, and returned to Heliopolis to have it excised.

9. *Statistical.*—The following list is a classification of a number of the cases attended to during this period. It does not include, however, anything like the total treated, for a number of reasons. Only those who were in Egypt in 1915 will ever realize the difficulties which were encountered, owing to the lack of material and of skilled assistance during the rush which followed the Dardanelles landing. The list stated represents the cases of which notes were taken, and which were treated at No. 1 Australian General Hospital, Heliopolis. Owing to the lack of clerical assistance, they do not include nearly the whole of those cases, and they do not include any of the cases treated in the other hospitals. The list, however, does give an indication of the relative distribution of cases and of the operative work, and must be read solely as an indication of that distribution:

Ophthalmia (chiefly Weeks's and a percentage of diplo-bacillary)	546
Blepharitis	15
Pterygium	8
Corneal opacities	6
Trachoma	17
Iritis	12
Cataract	8
Foreign bodies in eye	14
Old injuries	9
Detachment of retina	2
Strabismus	16
Concussion blindness	4

Refraction cases:		
(a) Hypermetropia	210	
(b) Myopia	30	
(c) Hypermetropic astigmatism ...	230	
(d) Myopic astigmatism	15	
	—	485
		1142

Operations performed

Excision	36
Iridectomy and extraction	11
Removal of foreign bodies	7
Pterygium	4
Minor operations	6
	64

Summing up the work, it is obvious that the business of an oculist in a war zone does not include the fine work he is accustomed to in civil practice. The greater part of his time is taken up with the treatment of ophthalmia and the cases of errors of refraction, but there is imposed upon him a far greater responsibility than appears in these activities. It is his business to discriminate between the cases which are fit and which are unfit for duty, and to see that the cases of hysteria and fraud are kept in the lines, and trivial cases treated at the front. It is his business to return those who do reach the base as rapidly as possible. In order to be useful and effect this result, he has to superadd to the expert knowledge gained in civil practice an entirely new and military objective, which calls into place a series of judgments which take time in acquisition, and are exceedingly valuable when once acquired.

ANNOTATIONS

The Beauty Specialist

We wish to draw the attention of ophthalmic surgeons—and would ask them to keep a record of cases which come under their observation—to patients who have been operated on by unqualified men trading as beauty specialists, under their own name or more frequently that of a fictitious institute. The following case has been brought to our notice.—A woman, aged 37, desirous of becoming a cinema actress and who, as she described it, had "baggy eyes,"

went to an Institute where, under an injection of some local anaesthetic, large pieces of skin were removed from both the upper and lower eyelids. Collodion dressings were applied, and the patient sent home. She suffered intense pain and swelling of the eyelids and conjunctiva, and, according to her own account, one of them became septic. We have also heard of a case in which the palpebral aperture had been enlarged by an external canthotomy performed for "small eyes." Apparently there is nothing in the British law which prevents such operations being performed by unqualified practitioners, unless a fatality occurs. This was instanced some years ago when some unqualified Indian oculists were brought before the courts for removing portions of the eyelids and conjunctiva, and were acquitted.

It would be of service if ophthalmic surgeons would collect similar cases so that some representation could be made with regard to this unqualified practice which seems to be on the increase.

Transactions of the Ophthalmological Society

Special interest attaches to the *Transactions* of the Ophthalmological Society of the United Kingdom, Vol. XXXVI, recently issued to members, for not only does it contain an account of the 1918 Congress of the Society but also of the meetings of two of the four affiliated societies, namely, the Oxford Ophthalmological Congress and the Midland Ophthalmological Society. Among the contributions of the affiliated societies the Doyne Memorial Lecture on "Ophthalmology and the War," by Sir William Collins, should be mentioned. It recalls vividly the memory of one whose name is dear to many of us, the late Robert Walter Doyne, founder of the Oxford Congress, and of much besides. For instance, to him is owing the foundation of the Oxford Eye Hospital and the inception of a diploma of ophthalmology in the University of Oxford. These were but the preliminary steps towards a more ambitious dream which he never lived to see fulfilled, which was the rendering of Oxford a centre of ophthalmology for the British Isles. Sir William Collins in speaking of him quotes the fine saying of Ralph Waldo Emerson, "An institution is the lengthened shadow of one man," and never was that truer than in the case of our colleague. The affiliation movement, carried out largely by the then President of the Ophthalmological Society, has our warmest approval, more especially at a time such as this when union is truly strength. Under this scheme the autonomy of the individual society is not affected, but an account of its work will appear in the *Transactions*. This is an advantage to those societies which have not in the past published a separate volume, as well as to those who belong exclusively to the

parent society, who will now enjoy the privilege of reading for themselves an account of the scientific work carried on by the other bodies.

The National Physical Laboratory

It is but fitting that in a technical journal such as this notice should be paid to the important work on optics that is done by the National Physical Laboratory at Teddington, of which the report for the year 1917-18 is before us. Since the outbreak of war, heavy demands upon the Optics Division of the Laboratory have been made by the testing of instruments, such as gun-sights and look-out telescopes and binoculars, and sextants, and material such as optical glass. The number of specimens of glass examined for refractive purposes has risen largely above last year's total. The tests are made on a Pulfrich refractometer, and experience shows that a properly constructed instrument of that type used under suitable conditions gives results only attainable by most other methods with the expenditure of much more time and trouble. There have been several requests for the examination for optical properties of specimens of glass not specially prepared for the purpose, and in such cases the tests were carried out by an immersion method. The method has proved adequate to enable the particular glass to be identified, although the accuracy has been less than that which is secured when suitably prepared specimens are tested. The Division has done a considerable amount of work dealing with optical calculations, chiefly concerned with economizing the time involved in calculations, either by extracting more complete information from rays traced through a system or by substituting a definite algebraic system of operations for tentative ray tracing in cases where the algebraic method has proved to be applicable as a final method of calculation. The algebraic methods aim at replacing the years of experience required in the other system by a definite course of operations which will, within the field of their applicability, lead to a satisfactory solution of the problem. A considerable part of the additional buildings now under construction at Teddington will provide accommodation for the testing of glass volumetric apparatus, most of which was formerly obtained from Germany. As it is now made in this country, the Committee of the Research Department dealing with the matter is anxious that the standardization of such glassware should be undertaken by the Laboratory.

Nerve Fibres of the Living Cornea

In the *Lancet* for November 23, 1918, will be found a short abstract of an article by J. Strebel, of Lucerne, *Correspondenzbl. für*

Schweizer Aerzte (p. 1,442, no date given), in which the author claims that he can demonstrate the nerve fibres of the living cornea by means of focal illumination with a Nernst lamp and a corneal microscope. The fibres appear as very fine, silver gray, opaque, round little bundles in the depth of the corneal parenchyma, at the limbus. They run a wavy course, coming nearer and nearer to the surface as they extend into the cornea, until they end immediately under the conjunctiva (? conjunctival layer of the cornea). Occasionally for the first millimetre or two of their course there is what Strebel recognises as a medullary sheath. Strebel says that the nerves cannot be mistaken for obliterated blood-vessels. Their opaque, silver-gray look, their wavy course, and their dichotomous branching, when this occurs, are all characteristic features.

ABSTRACTS

I.—HETEROCHROMIA

(1) **Bistis, J. (Athens).—Clinical and experimental investigations on the aetiology of heterochromia.** *Arch. of Ophthal.*, July, 1915.

(1) **Bistis** calls attention to the cases in which the iris becomes decolourised, without visible cause, at a period after the pigmentation of the stroma has become fully developed. He contends that this is a pathological process, as shown by: (1) the frequency with which cataract develops in these eyes, and (2) the presence of keratitis punctata. Symptoms of sympathetic paralysis have often been observed in such cases. Bistis extirpated the superior cervical ganglion of one side in rabbits, and found changes in the iris in one of them. Under microscopic examination, the eye of the operated side showed very distinct reduction of pigment, as compared with its control fellow. In the other three cases the rabbits died too soon to allow the experiment fair play, but in two of the three the irides were observed to have paled perceptibly before death. A case would appear to have been made for a further series of experiments.

In this connection an observation made some years ago by the reviewer may be of interest. In India, where deeply pigmented cataracts are commonly met with, he found that an examination of the fundus, after extraction, not infrequently revealed a very extensive absorption of the retinal pigment layer, and the consequent laying bare of the vessels of the choroid to ophthalmoscopic observation. There would appear in these cases to be a clear connection between the development of primary cataract and the

interference with, if not the migration of, the pigment of the coats of the eye. Taken with the Indian experience, and with Burdon-Cooper's work on tyrosins in connection with cataract Bistis' work is full of suggestion. R. H. ELLIOT.

(2) **Ellett, E. C. (Memphis). — Heterochromia iridis, heterochromic cyclitis, and allied conditions.** *Trans. Amer. Ophthal. Soc.*, Vol. XV (1917), p. 31.

(2) **Ellett** reports seven cases of heterochromia iridis (with uveitis, 3, with cataract, 2, and with cataract and glaucoma, 2), in addition to 5 of uveitis with some attendant discolouration of the iris and glaucoma, In discussing heterochromia iridis he points out that the condition is not rare, usually occurs in brunettes, and in the large majority of instances is observed before maturity. Pathological changes, which are almost invariably observed to occur in the lighter coloured eye, consist in: (1) Low-grade cyclitis, as shown by "keratitis punctata" and especially by vitreous opacities; (2) Cataract; and (3) The development of glaucoma simplex. Its underlying cause is not known. Ellett discusses the possible relation of the cervical sympathetic to the condition. S. S.

(3) **Fuchs, Ernst (Vienna). — On heterochromia with some remarks on congenital anomalies. (Ueber Heterochromie nebst Bemerkungen ueber angeborene Anomalien.)** *Arch. f. Ophthal.*, Vol. XCIII, Part iv, 1917.

(3) **Fuchs** describes the microscopical anatomy of two cases of heterochromia of the iris. The first case was that of a woman aged 48, with heterochromia, keratitis punctata and secondary cataract. Fuchs removed the cataract successfully with a visual result of 6/12. Six years later the eye was attacked by glaucoma and excised by Axenfeld, who sent sections to Fuchs. He sums up his findings in these sections as follows:—

"The pigmentation of the iris appears to be that of a naturally unpigmented eye. There are no indications that the iris was more strongly pigmented at an earlier time and had lost its pigment through pathological processes (inflammation, raised intra-ocular pressure). In such cases the remains of the destroyed chromatophores are found as irregular clumps or free granules of pigment, whereas in this eye the few pigment-containing chromatophores are of normal appearance. The supposition of a previously existing defective pigmentation agrees with the account given by the patient who stated that the difference in colour had always been present.

The inflammatory changes consist in precipitates on the back of the cornea and infiltration of the inner coats of the eye, which is most strongly marked in the iris.

As a result of the inflammation is to be regarded the increase in

the superficial epithelium of the iris and ciliary body ; the thickening of the dilatator layer, alterations in the posterior pigment layer of the iris, increase in the pigmented and unpigmented layers of the ciliary epithelium. To these results also should be attributed the slight atrophy of the inner layers of the retina and optic nerve, and finally those changes which are not demonstrable in the preparations, namely, the raised pressure, vitreous opacity and cataract."

Fuchs' second case was that of a man aged 64, who died as a result of septic peritonitis. Fuchs was present at the autopsy, and noticing the heterochromia, obtained the eyes for microscopic examination. The patient had made no previous complaint about his vision. Microscopic changes were found in both eyes. The congenital anomalies found were trivial and concerned the sphincter and ciliary muscle in the darker eye only. The pigment stroma of both eyes was formed of dark brown granules, the only difference between the two being that the granules were more numerous in the dark eye. As in the first case, the lack of pigment did not appear to be due to any inflammatory process. There was evidence of slight diffuse inflammation in both eyes equally, consisting of isolated foci of epithelioid cells. The inflammation had not been of sufficient severity to lead to any cell wandering or precipitation on the cornea.

Fuchs had previously stated, as a result of the examination of a piece of iris removed from a heterochromic eye and hardened in alcohol, that a characteristic symptom of the condition under discussion was an increase in the nuclei in the iris and a fibrinous deposit. This he now believes to be an error due to the unsatisfactory fixation by alcohol. Such a condition was not present in the eyes described above, and proper fixation of the eye from which the first piece of iris had been taken, after removal had been done at a later date, also failed to confirm the first result.

Fuchs sums up the characteristics of the type of inflammation associated with heterochromia as follows :—

" It consists in a slight diffuse infiltration of the uvea with lymphocytes and plasma cells, with occasional eosinophile and mast cells in addition. Whether the epithelioid cell foci found in his second case and in that of Schlippe belong to this form of inflammation cannot at present be determined.

2. On the surface the inflammation extends in two ways.

On the one hand, cells enter the uvea, clump together and form precipitates ; on the other, through proliferation of the epithelium of the ciliary body, deposits are formed on this structure, which resemble those which occur in other cases of chronic iridocyclitis.

3. There is no tendency to plastic exudation. Posterior synechiae and the formation of pupillary membranes are not present.

4. The inflammation is very prolonged, as clinical observation shows, with typical symptoms of iridocyclitis.

5. Although the inflammation lasts for many years it does not lead to deeper changes in the uveal tissue as is usual in chronic iritis. Whether the slight atrophy of the retina, which was observed in my first case, also occurs in other cases, and what its meaning may be must be determined by further researches. The visual acuity in cases of heterochromia is not usually more affected than can be accounted for by the opacity of the media. Clinical investigation, with accurate observation of the colour fields in heterochromia cases, should help in the future to elucidate this question.

Lental opacity occurs in many, but by no means in all, cases of heterochromia. Since the lens so often remains clear even in severe cases of iridocyclitis, it is not correct to attribute the lens opacity to the moderate amount of uveal inflammation alone. We must suppose either that heterochromia has a peculiarly injurious effect on the lens, or that in the cases where cataract appears there is a faulty development of the lens which predisposes to early opacity."

E. E. H.

II.—ATROPHY OF THE IRIS

Feingold, Marcus (New Orleans).—Essential atrophy of the iris. *Amer. Jl. of Ophthal.*, January, 1918.

Feingold's communication, which is illustrated with one coloured plate of the clinical appearances and five microphotographs of the histology of the condition, concerns a married woman, aged 37, the vision of whose left eye had become reduced to doubtful perception of light in association with attacks of pain and the formation of a number of holes and atrophic areas in the ciliary portion of the iris. The intra-ocular pressure was +3 (38 Schiötz). The eye was enucleated, fixed in Zenker's solution, and embedded in collodion. The defects seen during life in the iris were found under the microscope to vary from complete holes to defects leaving the pigment epithelium intact. The root of the iris was adherent to the cornea to the extent of 0.6 to 0.8 mm. Schlemm's canal was open and contained blood. The meshes of the pectinate ligament could not be made out distinctly because of the dense adhesion of the root of the iris to the cornea. The ciliary body was atrophic, and the muscle was thin and had undergone hyalin degeneration. The vitreous body showed a small detachment in the posterior portion. The ganglion cells were absent from an area which began at the temporal margin of the disc and extended 1.5 mm. toward the macula. On the temporal side of this area they suddenly reappeared, and this area, which was at least 1.5 mm. by

0.576 mm., was characterized by peculiar bodies occupying the place of the ganglion cells, but were here and there found to extend as far as the inner nuclear layer. They were much larger than the normal ganglion cells. Some of them showed a long process which ran parallel with the nerve fibres, and could often be traced for about 70μ. They were all surrounded by a clear space which was bridged over by fine threads or ribs connecting the bodies with the fibres surrounding them. They contained nuclei. The author concludes that they were degenerate ganglion cells. A glaucomatous excavation, 1·2mm. in depth, filled with a dense coagulum, occupied the optic disc, and the lamina cribrosa was bulged backwards. In the temporal part of the optic disc, immediately behind the lamina cribrosa, was an area corresponding to a vertical diameter of 0.84 mm., characterized by an entire absence of nerve fibres, and containing only fine fibres forming a loose network with large clear spaces here and there. The central artery and vein, the walls of which were normal, were patent, and showed only a slight amount of perivascular infiltration with lymphoid cells in some sections.

In discussing the histological examination of the eye, Feingold takes up in particular: (1) the defects in the iris; (2) the signs of glaucoma; (3) the changes in the optic nerve behind the lamina cribrosa; and (4) the changes in the retina at the temporal side of the disc. (1) The history, as well as the clinical and the histological examinations, fails to disclose any cause for the peculiar atrophy of the iris. Evidences of inflammation that might have caused the changes in the iris were limited to slight infiltration and pigmentation around Schlemm's canal. On the other hand, all the defects were situated in the ciliary portion of the iris, and histological changes in the blood-vessels typical of degeneration were found almost exclusively in the remnants of the ciliary portion of the iris, while such changes where almost wholly absent from the pupillary portion. (2) The atrophy of the iris cannot be considered as the result of glaucoma for several reasons. First, when it occurs ectropion of the retinal pigment is almost constantly present, and it was not found in the histological examination of the present case. Second, the atrophic changes began not at the sphincter region, but in the ciliary portion of the iris. Third, glaucomatous atrophy seldom extends through the whole thickness of the iris. All the appearances might be explained by primary changes in the blood-vessels based upon some embryological malformation. (3) The changes in the optic nerve behind the lamina cribrosa and the cavernous degeneration of Schnabel were also seen in Wood's case, the only other one examined histologically. (4) In discussing the retinal changes Feingold reaches the conclusion that the peculiar bodies found on the temporal side of the disc do not represent varicose

nerve fibres, but, as already stated, degenerate ganglion cells, similar to those found by Schreiber and Wengler in the retina of the rabbit after scarlet R. had been injected into the anterior chamber.

Feingold admits that his case offers no positive explanation of the peculiar clinical entity of essential atrophy of the iris, although some features of the histological examination could be interpreted to mean that congenital vascular disturbances in the neighbourhood of the smaller iris circle may have induced the changes in the iris. It affords, moreover, no explanation of the mechanism of the glaucoma, common in all such cases. The author suggests that some of the histological changes found may have been caused by substances set free by destruction of the tissue of the iris. S. S.

BOOK NOTICES

Transactions of the Ophthalmological Society of the United Kingdom, with which are affiliated the Egyptian Ophthalmological Society, Midland Ophthalmological Society, North of England Ophthalmological Society, and the Oxford Ophthalmological Congress. Vol. XXXVIII. Session 1918. London: J. & A. CHURCHILL, 7, Great Marlborough Street. 1918. Price 12s. 6d. net.

This well-illustrated volume of 384 pages is of particular interest, since it contains not only an account of the proceedings of the Ophthalmological Society of the United Kingdom at its meeting in May, 1918, but also the reports of the Oxford Ophthalmological Congress and of the Midland Ophthalmological Societies, two of the four societies now affiliated with the parent body. Mr. E. Treacher Collins, in his presidential address, speaks of the volume as "considerably reduced in bulk, due to the thinness of the paper," and goes on to say that "it is only superfluous matter with which it has had to dispense, the number of its pages and the amount of interest in its material being well up to the average." The *Transactions*, among other things, includes discussions "On contagious diseases of the conjunctiva" and "Plastic operations of the eyelids," and contains an interesting report of the committee on "The conditions affecting the standard of vision in the British Army," to which is appended a communication by Messrs. Traquair and Paterson dealing with the same subjects. These discussions and communications, as well as the other contents of the volume, will be noticed in due course in abstract form in our columns. The officers of the Society now are: *President*: J. B. Story; *Vice-Presidents*: E. Treacher Collins, W. G. Sym, J. H. Fisher, and W. T.

Lister, C.M.G.; *Treasurer:* Arnold Lawson; *Council:* A. H. H. Sinclair, R. R. Cruise, J. F. Cunningham, S. A. K. Wilson, A. B. Cridland, and J. G. Clegg; *Secretaries:* M. S. Mayou and R. R. James.

S. S.

Diseases of the Eye, by J. HERBERT PARSONS, D.Sc., M.B., B.S., F.R.C.S. Third edition, with 18 plates and 319 text figures. London: J. and A. Churchill. 1918. Price 16s. net.

The second edition of this excellent volume was fully noticed in the *Ophthalmoscope* for 1912, one of the predecessors of this journal. It seems hardly necessary, therefore, to repeat in general what was there said. In the preface to this third edition the author points out that the most noteworthy additions are a new section on Symptomatic Diseases of the Eye, short accounts of less common disorders of the eye, and extensive additions to the operative and other measures of treatment. In the opinion of the reviewer, the chapter (xxix) in the new section dealing with Symptomatic Diseases of the Eye which is headed "Ocular Manifestations of Diseases of the Nervous System," while extremely useful for reference, is so compressed that it is very difficult for the student to understand. The apparent difficulty may possibly be due to the reviewer's defective recollection of the exact anatomy of the nervous system; but, on the other hand, such "defective recollection" is not a very uncommon failing. The chapter is essentially so good and useful that some expansion of the text in the direction of explanations seems called for when the author makes up his next edition.

In the second edition, the complications which may follow the extraction of cataract were merely mentioned in connection with the operation, the details being given under the respective headings of iritis, etc. These complications are now dealt with in detail immediately after the descriptions of operations, a much more satisfactory place for them. In the former volume, trephining for glaucoma was merely mentioned, and, indeed, the word was not to be found in the index. This has now been remedied and a clear description given of Elliot's method of operating. The limitations of the trephine operation are recognized, but the author is wholly in favour of it for chronic glaucoma. For acute glaucoma he considers that iridectomy, performed early, is the operation of choice. The trephine operation is here as difficult as iridectomy, while the results are less favourable. The author's expression of opinion on these important points is perfectly clear. Regarding tonometry, which was not previously mentioned at all, one rather gathers that Parsons has no very great faith in the tonometer as an instrument of precision. There is a short description of the Schiötz instrument. The chapter on injuries has been extended, and a short section added on War Injuries. The latest Haab magnet and the

Mellinger ring magnet are illustrated, and their employment is described. In dealing with colour blindness, the description of tests has been considerably extended, and the author finishes the subject with the following sentence : " Defects of colour vision have led to much acrimonious discussion. Their detection may be easy, but is often difficult. No theory which has yet been brought forward is wholly satisfactory, and no single test is infallible." But one might go on indefinitely selecting interesting matter from this volume. Enough has been said to indicate that the author has made a very good book still better than it was.

Regarding the make-up of the volume, one notices that there are fewer pages than before, but more lines to the page. The page is the same size as formerly. Certain paragraphs, too, have been placed in smaller type. The plate with samples of Holmgren's wools has been omitted. The index has been revised and made more complete.

ERNEST THOMSON.

Treatment of Senile Cataract. By Lt.-Col. H. Kirkpatrick, I.M.S., Madras: The Modern Printing Works, Mount Road.

This pamphlet, copies of which may be obtained from the Secretary of the Madras College Association, consists of a reprint of articles on cataract published in the ***Transactions*** of the Association by Lt.-Col. H. Kirkpatrick, Superintendent of the Government Ophthalmic Hospital at Madras. He describes the method of operation employed by him, which differs in some respects from that adopted in Europe. In diabetic patients about to be operated on for cataract, coma should be guarded against by testing the urine for diacetic acid, and by keeping them on sodium bicarbonate before, during, and after the extraction. As to the general condition of the patient, Kirkpatrick thinks that if there is a prospect of life for six months and no sight in the other eye operation should be undertaken. He regards Herbert's method of conjunctival disinfection by sublimate douching (1 : 3000) as the best. With regard to the actual operation, he insists upon the necessity of employing dry sterile instruments. He does not favour expression of the lens in its capsule, of which one disadvantage, even when successfully performed, is that the hyaloid membrane approaches the wound too closely, and may thus form a track along which sepsis may pass from the surface to the ciliary body. In order to secure steadiness of hand, the author employs a wedge-shaped block placed alongside the patient's head. The forearm, from the elbow to near the wrist, is rested upon this block, and the ulnar margin of the hand is supported by the skull. He prefers a peripheral iridectomy. He employs a method of capsulotomy introduced into Madras by Col. E. F. Drake-

Brockman. It consists in lacerating the capsule by a Bowman's discission needle before the section is made. After the lens nucleus has been delivered by pressure, the cortex is got rid of by McKeown's irrigator, the systematic use of which was popularized in Madras by Lieut.-Col. R. H. Elliot. The hint is given that a large lens may often be delivered through a small section by causing the wound to gape and the lens to present by applying light pressure at the lower part of the eyeball and then by transfixing the lens on a Bowman's needle. By using gentle pressure below and rolling the nucleus over like a wheel with the needle it can often be delivered without injury to the eye under circumstances in which a quite unjustifiable amount of pressure would be necessary to deliver it in the ordinary way (R. H. Elliot). The author is not alone in believing that it is a mistake to insist upon the patient looking downwards while the lens is being extracted, and that it is best delivered whilst the eyeball is turned up. While the speculum is between the patient's eyelids it is advisable to pull the orbicularis up and to hold it in place by the thumb or the unoccupied fingers of the free hand. When the operation is finished it is well to drop atropin into the eye.

Kirkpatrick claims for the operation he describes, the essential features of which are the peculiar method of capsulotomy and the systematic use of irrigation, that it satisfies the desiderata of removing the maximum quantity of lens nucleus, and of inflicting the minimum of trauma and disturbance of the ocular tissues.

S. S.

The Australian Army Medical Corps in Egypt. SIR JAMES W. BARRETT, K.B.E., C.M.G., Lieut.-Col. R.A.M.C., and Lieut. P. E. DEANE, A.A.M.C. Pages 14 and 259. Demy 8vo, 37 plates. London: H. K. Lewis & Co., Ltd., 136, Gower Street, W.C.1. 1918. Price 12s. 6d. net.

Sir James Barrett, Lieut.-Colonel, and Lieut. P. E. Deane, Quartermaster of the First Australian General Hospital, Egypt, in the volume before us tell the tale of the Australian Army Medical Corps in Egypt, and a remarkable story it is. For example, a hospital of 520 beds was compelled to expand to a capacity of about 10,500 beds and the way difficulties were got over was most interesting. It is no part of our purpose to enter into such details, interesting though they are in themselves. It will suffice if we touch upon one or two points likely to be of interest to the readers of the journal. In the First Australian Hospital at Heliopolis, an ophthalmic department was opened upon the first floor of the building, which had formerly been the Palace Hotel. As there were few oculists in Egypt at this time other than those attached to this hospital, the eye department rapidly assumed formidable proportions.

There were usually from 60 to 100 in-patients and sometimes 100 out-patients were seen in a day. From the opening of the hospital to September 30, 1915, 1,142 ophthalmic cases were treated, the largest number being made up of the various forms of acute conjunctivitis, chiefly of the Weeks's variety. Not a single instance of sympathetic ophthalmitis was met with. Errors of refraction formed almost one-third of the conditions treated. In the examination of recruits, cases were not infrequent of men with glass eyes, and several men possessed practically only one eye. The authors express the guarded opinion that one-eyed men should "hardly be sent to the front." The amount of refraction work leads to the expression of opinion that a working optician should accompany each army. With regard to malingerers, their sight soon returned when the men learned that before being sent home, they would be subjected to an examination by an expert. S. S.

The Twin Ideals: An educated Commonwealth. By Sir JAMES W. BARRETT, K.B.E., C.M.G., Lieut.-Col. R.A.M.C., 2 vols. Demy 8vo. London: H. K. Lewis & Co., Ltd., 136, Gower Street, W.C.1. 1918. Price 25s. net.

Sir James W. Barrett's two volumes, illustrated with maps and diagrams, are made up of a number of political and sociological essays mostly reprinted from the columns of the Melbourne *Argus* in which they originally appeared. They are noticed here because two of them deal with subjects of perennial interest to ophthalmic surgeons, namely, myopia and trachoma. After pointing out that short-sight has never developed to the same extent in Great Britain, America, and Australia as in Switzerland and Germany, the author expresses the fear that we are tending to go the same road. He gives a popular account of the mischief done by myopia, and advocates the formation of schools for the short-sighted, laying down the cardinal features that should distinguish such institutions, as the abolition of evening work, instruction by mouth and by ear, education in the open-air, and the training of the children for mechanical or for out-door occupations. The other essay (written conjointly with Dr. W. F. Orr) deals with the distribution of trachoma in the State of Victoria. The method adopted for the collection of statistics was by the determination of the place of residence of all cases of trachoma presenting themselves at the Victorian Eye and Ear Hospital. The obvious drawbacks of such a method are insisted upon by the author. Figures giving the mean summer temperatures and the mean humidities for the various places concerned are included. It is thought that, broadly speaking, heat, dryness, and dust are the fundamental underlying factors in the distribution of trachoma. S. S.

CORRESPONDENCE.

ILLUMINATION OF SNELLEN'S DISTANT TEST TYPES

To the Editor of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

SIR,—I read in the January number of THE BRITISH JOURNAL OF OPHTHALMOLOGY that the Council of British Ophthalmologists has issued directions for the illumination of test types in estimating visual acuity.

With the prescribed amount of illumination the test becomes purely one of definition, and as this is the case it seems a pity that one of the obvious defects of most existing sheets of test types was not guarded against at the same time.

Perfect definition implies that all points of the letter be brought to a focus in the retinal image; the greater the departure from this condition, the wider become the confusion circles, and the bigger the blur on the edges of the retinal image. The critical factor in the test of definition is the extent to which the confusion circles reach across the intervals which separate the limbs of the letters; with a slight blur the letters may still be distinguished, it is only when the blurred edges of the limbs overlap that the letter becomes indistinguishable. It is obvious that no two parts of the letter should be wider apart than the unit interval which is proper to each grade of letter. There are certain letters, such as O, C, D, L, which cannot be designed in conformity with this condition. These letters should be omitted, as also should such letters as A and V, whose shape betrays their identity even when they are blurred.

I wish to suggest that in a scheme for a universally comparable test this condition should be considered.

I am, Sir, yours faithfully,

W. A. DIXEY.

3, NEW BOND STREET, W.

NOTES

Deaths

WE regret to announce the recent deaths of two distinguished physicians who were members of the Ophthalmological Society of the United Kingdom, namely, Thomas Buzzard, aged 87 years, and Leonard G. Guthrie, aged 60 years.

The former was an original member of the Society, in which he had held the offices of councillor (1881-2) and vice-president (1888-91). When he resigned his membership some few years

ago he was elected an honorary member. We offer our sincere sympathy to his son Dr. E. F. Buzzard.

Guthrie, who graduated in Arts at Oxford before taking up the study of medicine, was an accomplished neurologist and an authority on the diseases of children. He was physician to the Western Ophthalmic Hospital. He was a man of great personal charm and culture. The author of *Vice versa*, who writes under the name of F. Anstey, is Guthrie's elder brother, to whom we offer our sympathies upon his loss.

We learn with regret of the death of Ivor William Joynt, civilian resident surgeon at the 3rd London General Military Hospital, Wandsworth Common, and a contributor to these columns. He was formerly house surgeon at the Royal London Ophthalmic Hospital.

* * *

Honours

THE K.C.V.O. has been conferred upon Sir G. Anderson Critchett, Bt., C.V.O., surgeon-oculist in ordinary to the King.

The C.B. has been awarded to Lt.-Col. H. L. Eason, C.M.G., R.A.M.C.

Among the consultants mentioned for distinguished services in a despatch from the Commander-in-Chief of the British Armies in France, we notice the names of Lt.-Col. G. M. Holmes, C.M.G., and Col. W. T. Lister, C.M.G.

* * *

British Eye Hospital in Jerusalem

THE Grand Priory of the Order of St. John of Jerusalem in England is making an appeal on behalf of the Eye Hospital it has long maintained in Jerusalem. The Hospital was used by the Turks as an ammunition store, and when General Allenby entered the city they blew it up and damaged it very seriously. The sum of £50,000 is required, and subscriptions may be sent to the Right Hon. Evelyn Cecil, M.P., St. John's Gate, Clerkenwell, E.C.1.

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Resignation of Sir William Collins

IT is announced that Sir William Collins will not seek re-election as a Member of Parliament for Derby. This is the more to be regretted at the present time when efforts are being made to increase medical representation in the House of Commons.

* * *

The Blind

A CANADIAN National Association for the Education of the Blind, with Dr. C. R. Dickson as president, has been formed. The Association already possesses a certain number of books for the blind.